Event Structure in

Natural Language Discourse

Sheila Rosalie Glasbey

Degree of Doctor of Philosophy
University of Edinburgh
1994

Declaration

I declare that this thesis has been composed by myself and that the research reported therein has been conducted by myself unless otherwise indicated.

Edinburgh, 27th June 1994

Sheila Glasbey

Abstract

We present new observations on the distribution of sentence-final 'then'. We develop an analysis which reveals the need to distinguish between times which are explicitly mentioned and those which are merely implicit in the description of events. The account is expressed formally in DRT (Kamp and Reyle 1993), and involves restricting the introduction of temporal discourse referents to cases where an **explicit temporal referent** is present.

We discuss possible problems with the DRT account in extending to larger fragments, and suggest that incorporating ideas from situation theory (Barwise and Perry 1983), along the lines of Cooper's situation-theoretic DRT (STDRT) (Cooper 1993b, 1993c) may overcome these problems. We present an alternative formalisation expressed in a version of Cooper's situation theoretic grammar (STG) (Cooper 1991). In this fragment, the distinction between explicit and implied temporal referents is made in terms of information about the utterance.

Observations are made concerning 'at the time' and 'at the same time'. In order to develop an account, we look at related non-temporal observations involving 'the X' and 'the same X' in discourse sequences, where X is a relational noun such as 'colour'. We develop an account in STDRT using the notion of **generalised role**, which we show is related to notions of thematic roles/relations used in the literature. Applying this account to the temporal data, we show how this explains the distribution of 'at the time' and 'at the same time' and allows us to formalise the discourse relation known as **backgrounding**.

We show how the incorporation of situations allows us to give a treatment of aspectual class and aspectual composition expressed in terms of event structure. We develop such an account and indicate how it may be incorporated into a grammar such as the STG one given earlier.

We conclude that there is a need to distinguish between information which is **explicitly described** by an utterance and information which is only **implicitly** present. In order to explain certain natural language observations, this distinction must be clearly made in the semantic representation. We demonstrate that situation theoretic DRT is a suitable framework for making the distinction.

Acknowledgements

Many people have helped me with this thesis. Without my supervisors, Robin Cooper and Elisabet Engdahl, it would never have got started, let alone finished. They were a constant source of advice, encouragement and inspiration. I think what I valued most from Robin was his willingness to listen to my ideas. Right from the start he made me feel I had a contribution to make, and this gave me the encouragement I needed to get going. His enthusiasm for the subject was infectious, and his depth of understanding and breadth of knowledge was invaluable in helping me sort out my ideas and relate them to other people's. His own research made this thesis possible, and he has aided and influenced the development of every part of it.

I must thank Elisabet for introducing me to Linguistics in Autumn 1988. After three of her lectures I decided that this was a subject I wanted to pursue. After four, I began to wonder, but by then it was too late — I was hooked. Elisabet has always been a source of sound advice and understanding, especially when it came to organising and presenting my ideas and preserving my sanity while writing up.

Both have been real friends as well as excellent supervisors, and I can't thank them enough.

Part of this work was carried out in the Department of Artificial Intelligence, and part at the Centre for Cognitive Science. These were supportive, stimulating and friendly environments to work in, and I thoroughly enjoyed my time in both places. Many of my early ideas were presented to the Natural Language group in AI, and I received lots of helpful comments from members of that group, including Jean Carletta, Ian Lewin and Graeme Ritchie. In CogSci, I have had much useful feedback from members of the Meaning and Computation and TASTELESS groups. The range of interests, knowledge and perspectives in these groups has been enormously helpful. Special thanks should go to Martin Mellor, with whom I've had many hours of discussion about things temporal, and who gave me very useful comments on chapter drafts. I'm also grateful to Marc Moens for helping me to sort out my ideas on 'then' etc., and providing some challenging counterexamples.

Others in the Centre for Cognitive Science and Department of AI who have helped in all kinds of ways include Alan Black, Jean Bunten, Lawrence Cavedon, Ivan Derzhanski, Martin Emms, Simon Garrod, Lex Holt, Khee Yin How, Betty Hughes, Laura Joosten, Ana von Klopp, Alex Lascarides, Jon Oberlander, Sheila Rock, Sue Sentance and Carl Vogel. Alan gave me lots of advice about computing. To him and others who were prepared to translate computer jargon into English for me, I'm forever indebted. Ana helped with the formatting of my thesis and offered a great deal of moral support, as did Sheila, Sue and Laura. Ivan and Lex were founts of knowledge regarding LaTeX. Jean and Betty were always ready with practical help. Carl and Lawrence helped me to understand channel theory, and I had helpful discussions with Alex, Jon, Martin E., Khee Yin and Simon on tense, aspect, discourse and anaphora.

Many people from elsewhere helped me, too. I received insightful comments on my early ideas on 'the same X' from Max Cresswell. David Dowty gave helpful and challenging remarks about a later version of this account. In July 1993, I attended the ASL/LSA conference on Logic and Linguistics at The Ohio State University, Columbus, Ohio, and received useful feedback on parts of Chapter 4. Chapter 2 benefited from the comments of the editors of Natural Language Semantics, Angelika Kratzer and Irene Heim, and those of an anonymous reviewer for that journal. The work on 'then' received an impetus from participants at EACL93 in Utrecht, who challenged me to broaden the scope of the account. I had valuable discussions at various times with Nick Asher, Jon Barwise, Bill Ladusaw, Alice ter Meulen, Görel Sandström, Finn Sørensen and Michael White, and with participants at the 'Events and Grammar' conference in Bar-Ilan, Israel, November 1993 and the Ninth Amsterdam Colloquium in December 1993. Email correspondence with Beverly Spejewski in Rochester gave me much-needed encouragement during the revision period.

To all these people, and many others who have helped, I offer my grateful thanks.

I'd also like to thank my friends who encouraged me to become a student for the second time, back in 1988. These include Anne-Marie, Maureen S., Connie, Peter and Maureen B.

Finally, I would like to thank my family. Chris has been a great source of strength, advice and encouragement, and I have always been inspired by his own attitude towards his work. Daniel and Emily have given me lots of encouragement, welcome distraction and fun. My parents, George and Betty Warren, have always supported me in whatever I wanted to do, and their unfailing love means a great deal to me. This thesis is dedicated to my family.

Contents

Chapter 1

Introduction

This thesis aims to use linguistic data to reveal the kind of theory of events that is needed for natural language semantics.

Two alternative approaches to such an enterprise are often taken in the literature. The first is what might be called sentence-based and looks at such features as aspect, aspectual class and aspectual composition, which are often regarded as sentence-internal. From these, conclusions are drawn about the ontology and structure of events that are needed in the theory. The second approach is more discourse-oriented, being concerned with the progression of time through discourse and its interaction with features like aspectual class. This approach regards temporal progression as a variety of anaphora and models it in a way that shares some similarities with pronominal anaphora.

In this thesis we follow the latter, discourse-based type of approach. We begin with some new observations on the distribution of sentence-final 'then',[1] which we view as expressing explicit temporal anaphora. We study sequences like:

(1.1) a. Daniel climbed Ben Nevis
      b. Gareth was a boy then

and:

[1] Although some of these observations have recently been made independently by others, we were not aware of these at the time of our investigations.

(1.2) a. Daniel climbed Ben Nevis

b. *Gareth climbed Snowdon then

and:

(1.3) a. Daniel climbed Ben Nevis in July

b. Gareth climbed Snowdon then

From these we develop an account which puts certain constraints on the kinds of events required by the theory and their identity criteria and part relations. Our analysis takes us into the area of discourse structure and how discourse conveys relations such as "elaboration" and "background" between events and/or states. We show how sentence-final 'then' both interacts with and helps to determine discourse relations such as these. We argue that it is necessary to distinguish between two uses of sentence-final 'then': one which refers back to an explicit temporal referent (ETR) such as 'in July' in (1.1a), and one which expresses discourse relations between eventualities. We develop an account which embodies this distinction and show how it may be expressed in a semantic theory, using discourse representation theory (DRT, Kamp and Reyle 1993) as our example. After pointing out some potential problems with the DRT account, we develop a second fragment in situation-theoretic DRT (Cooper 1993b, Cooper 1993c), and show how this overcomes the problems we identified.

We move on (in Chapter 4) to look at sentence-final 'at the time' and 'at the same time' and their distribution in sequences similar to the ones with 'then'. In order to account for our observations we step aside from temporal matters and look at sequences involving relational nouns like 'the colour' and 'the same colour'. Having developed an account of these, we apply it to the temporal examples and show how it can explain the distribution of 'at the time' and 'at the same time'.

Once we have laid the foundations of our theory of events in Chapters 1–4, we turn in Chapter 5 to investigate how those temporal phenomena traditionally analysed at the sentence level (aspectual classes, aspectual composition, etc.) can be incorporated into the theory. In particular, we show how previous accounts of event structure, such as that of Moens (1987), can be expressed in it, allowing us to capture formally the distinctions between the aspectual classes. We also give an account in our theory of aspectual composition which is closely based on those of Verkuyl (1989) and Krifka (1992).

Thus we aim to show that the theory of events that we developed in earlier chapters to express discourse temporal phenomena can be extended to cover more traditionally sentence-internal phenomena in a way which throws some useful illumination on these.

The breakdown of material into chapters is as follows:

Chapter 2

We begin by presenting the observations concerning sentence-final 'then' in two-sentence discourse sequences. On the basis of these we develop an analysis which distinguishes between two uses of 'then' described above: the use which conveys reference to a previously-mentioned time and the use which expresses a particular discourse relation. We show how this distinction may be formalised in DRT by restricting the introduction of temporal discourse referents into the universe of discourse of the current discourse representation structure (DRS) to cases where explicit reference to a time is made. We call such references **explicit temporal referents** (ETRs). ETRs include frame adverbials (e.g. 'in July') and instantaneous adverbials (e.g. 'at 2pm') but not 'for'-adverbials such as 'for two hours'. When there is no explicit mention of a time (i.e., no ETR is present) such as in (1.2a), an event discourse referent but no time discourse referent is introduced into the DRS.

We develop a grammatical fragment on the above lines that is an extension and modification of the DRT fragment of (Kamp and Reyle 1993, Chapter 5), and show how the grammar and construction rules give the required readings for sequences containing sentence-final 'then'.

However, we point out, too, that the DRT account may be too restrictive in that in larger fragments there may be problems with allowing a temporal discourse referent only to be introduced when an ETR is present. In particular, our analysis of 'at the time' and 'at the same time' in Chapter 4 will show that it is very useful to allow temporal referents to be introduced by what we call 'inferred' (as opposed to explicit) times. But the distinction motivated by our analysis of 'then' still needs to be made somehow. We address this problem in Chapter 3.

Chapter 3

In this chapter we show how situation-theoretic DRT (STDRT) (Cooper 1993b, 1993c) may be used to make the distinction we require while avoiding the potential problem with the DRT version discussed above.

We begin by introducing the basic ideas of STDRT and the notation employed. This includes a brief introduction to situation theory (Barwise and Perry 1983, Barwise 1989) followed by a discussion of the situation theoretic grammar (STG) developed in (Cooper 1991). We show how Cooper's STG may be extended to cover the processing of a range of tense and aspect constructions. This involves us in a consideration of how best to incorporate temporal information into STG. We consider how spatial information should be represented and conclude that 'place' should be treated in a similar way to time. We show too how STG may be extended to process discourse, following Cooper's STDRT and incorporating ideas from (Johnson and Klein 1986).

Next we build in our account of 'then'. This differs from the DRT account in the way that we make the distinction between explicit and inferred times. In the new fragment we make use of the possibility afforded by STDRT of including information about the utterance in our semantic representations. This allows us to introduce temporal discourse referents corresponding to both explicit and inferred times, but to record whether a particular temporal referent was introduced "directly" by an ETR or "indirectly" by inference. This information is thereby made available for the processing of 'then'.

Chapter 4

Here we consider in more detail some observations made in Chapter 2 about the distribution of sentence-final 'at the time' and 'at the same time' in discourse sequences. In order to obtain some insight into the behaviour of these temporal constructions we turn to some related non-temporal sequences involving phrases like 'the colour' and 'the same colour', such as (1.4a,1.4b–1.4d):

(1.4) a. Emily has a new coat
b. Fiona's scarf is the same colour
c. *Fiona's scarf is the colour
d. Fiona likes the colour

We develop an analysis of 'the X'/'the same X' (where X is a relational noun such as 'colour') in terms of discourse Roles, which are based on the idea of role anaphora (Garrod and Sanford 1990). We introduce the notion of generalised Role (GR), which we suggest has interesting connections to the notion of thematic role widely used in the literature (see, for example, Dowty 1991). In addition, we show that the constraints on the use of 'the same X' in examples like:

(1.5) a. Emily watched a film
b. Fiona videoed the same film

are very similar to the constraints on coordination in single-sentence examples like:

(1.6) Emily watched and Fiona videoed the same film

where thematic roles are involved in both sets of cases.

The GR analysis allows to return to our observations on the distribution of 'at the time' and 'at the same time' and to explain them. This leads to a proposal for the formalisation of the discourse relation often called 'backgrounding' in the literature, which is widely used but has not in our view been adequately formalised in previous work.

Chapter 5

In Chapter 5 we address some issues that were given a rather perfunctory treatment in developing our DRT and STDRT fragments for 'then'. These include phenomena which, as we said earlier, are generally treated at the "sentence level", such as aspectual class and aspectual composition.

We begin by looking at how aspectual class distinctions may be expressed in STDRT. Building on work by Cooper (1985), we show how modelling eventualities as situations allows us to express distinctions such as the homogeneous/non-homogeneous property of eventualities. We show too how Moens' nucleus theory of event structure and his proposal that aspectual distinctions concern which parts of the nucleus are described (Moens 1987, Moens and Steedman 1988) may be formally expressed in our framework. The situation-theoretic notion of constraint allows us to distinguish clearly between those parts of the nucleus that are directly described by an utterance and those parts of the nucleus which may be inferred by the hearer on the basis of constraints. Making this distinction allows us to clear up some problems regarding Moens' aspectual network by formalising the notion of "focusing" on a particular part of an event.

We then turn to aspectual composition and begin with a discussion of various approaches that have been taken in the literature — in particular those of Moens (1987), Verkuyl (1989) and Krifka (1992). We consider the relative merits of these accounts and argue in favour of an information-preserving approach that incorporates Moens' insights about event structure. We show how such an account may be developed and expressed in our STDRT framework. In this account, the aspectual class of an eventuality described by a discourse is built up from lexical information about the verb/relation together with information about the nature of subject and object NPs and various kinds of temporal adverbials. Once again situation theoretic constraints prove useful in expressing these interactions.

Chapter 6

Here we summarise, present our conclusions, and offer suggestions for further work.

Chapter 2

An Analysis of Sentence-Final 'then'

Note: Sections 2.1–2.9 of this chapter are based on a paper which appeared in a recent issue of *Natural Language Semantics* (Glasbey 1993c).

2.1 Introduction

In this chapter we will make some observations concerning the distribution of sentence-final 'then', and carry out a detailed analysis. This will lead us to the conclusion that it is necessary to distinguish between two uses of sentence-final 'then', these being:

1. As a temporal anaphor referring back to a previously established explicit temporal referent (ETR).
2. As a means of expressing relations between states/events, where no ETR is required.

A way of making this distinction in Discourse Representation Theory (DRT) (Kamp and Reyle 1993) is proposed. This involves restricting the introduction of temporal referents into the universe of discourse to cases where certain types of temporal adverbials are present. In other cases, event or state referents but not temporal referents may be introduced. This contrasts with previous DRT accounts of temporal phenomena, which employ no such distinction.

We will formalize our account by developing a fragment which extends Kamp and Reyle's DRT treatment of temporal reference so as to incorporate our analysis.

2.2 Some Observations About 'then'

We begin by observing that it is possible to follow sentence (2.1a) with (2.1b):

(2.1) a. Daniel climbed Ben Nevis in July
 b. Gareth climbed Snowdon then

where the sequence (2.1a,2.1b) is interpreted as conveying that both Daniel and Gareth climbed their respective mountains at some time in the July in question. This meaning is distinct from the interpretation favoured by placing 'then' at the beginning of the sentence, as in (2.1c):

(2.1) c. Then Gareth climbed Snowdon

The only interpretation of the sequence (2.1a,2.1c) seems to be that Gareth's climb took place after Daniel's climb.

We seem to have a clear distinction here between what we might provisionally call a **cotemporal** use of 'then', (2.1a,2.1b), which could perhaps be paraphrased 'at that time', and an **update** use of 'then', (2.1a,2.1c), paraphrased roughly by 'next' or 'afterwards'. The generalisation we are making at this point applies to **simple past accomplishments** only. We will extend our analysis to the other Vendler classes in Section 2.5.[1]

[1]It is important to note that our claim does not necessarily hold in cases where we can get a non-narrative interpretation for consecutive events (e.g., where the events occur as a temporally unordered list) or where both sentences describe the same event. Such cases are dealt with in a later section.

In these examples there appears to be a syntactic correlation between the meaning of 'then' and the position of 'then' in the sentence. Sentence-initial 'then' is updating; sentence-final 'then' is cotemporal. However, it may also be possible (for some speakers at least) to get an update reading for sentence-final 'then', perhaps especially if 'in July' is removed from (2.1a), giving:

(2.2) a. Daniel climbed Ben Nevis
      b. Gareth climbed Snowdon then

Sequence (2.2a,2.2b) illustrates first of all that the syntactic correlation is not watertight – but it also brings out a point of greater interest: The cotemporal reading does not appear to be available at all for (2.2a,2.2b). There seems to be no way we can interpret this sequence to mean that Gareth's climb took place cotemporally (or even approximately cotemporally — overlapping, perhaps) with Daniel's climb. For some speakers, (2.2a,2.2b) simply sounds unacceptable; for others, the update reading is available but the sentence is judged to be stylistically poor (it would be much better with sentence-initial 'then').[2]

Note that if we replace 'then' by 'at that time' we get a similar result:

(2.1) a. Daniel climbed Ben Nevis in July
      d. Gareth climbed Snowdon at that time

(2.1a,2.1d) forms an acceptable sequence, whereas (2.2a,2.2c):

(2.2) a. Daniel climbed Ben Nevis
      c. Gareth climbed Snowdon at that time

[2]A third position for 'then' is available — as in 'Gareth then climbed Snowdon'. We have chosen to leave aside pre-verbal 'then'. In many cases it appears to be a rather literary or formal version of sentence-initial 'then'. Perhaps it conveys rather more in the way of contingency or consequence than sentence-initial 'then'. However we do not consider it further here.

does not sound completely acceptable. Replacing 'at that time' with 'at the time' does not yield an acceptable sequence in either case, as shown by (2.1a,2.1e) and (2.2a,2.2d):

(2.1) a. Daniel climbed Ben Nevis in July
e. Gareth climbed Snowdon at the time

(2.2) a. Daniel climbed Ben Nevis
d. Gareth climbed Snowdon at the time

Let us consider first why (2.1a,2.1b) and (2.1a,2.1d) are acceptable, while (2.2a,2.2b) and (2.2a,2.2c) are not. The difference is that (2.1a) makes mention of a particular "time" — it contains what we will call an **explicit temporal referent** (ETR). Sentence (2.2a) contains no such temporal referent. In (2.1a) the ETR is a temporal 'frame' adverbial. Note that other types of temporal adverbials can also work in this way (e.g., an 'at'-adverbial if the sentence describes an instantaneous event), but that certain types of temporal adverbials do not work as ETRs; e.g., completive 'in'-adverbials or 'for'-adverbials. Thus:

(2.3) a. Daniel climbed Ben Nevis (in four hours / for four hours)
b. Gareth climbed Snowdon then

is not acceptable.

The behaviour of 'then' in (2.1b) and (2.2b) might be described as **anaphoric** with respect to time. Its use seems to refer back to some previously introduced temporal referent. On encountering 'then', we look for such a referent, and find it in (2.1a) ('in July') but not in (2.2a) — hence the unacceptability of (2.2a,2.2b).

In other words, the sequence (2.2a,2.2b) sounds odd unless we already have a particular time in mind — one that was established earlier in the discourse or is somehow present in the context (e.g., suppose that the month of July was somehow highly focused in the preceding discourse). Thus, it appears that mention of an **event** in (2.2a) does not automatically make available the **time** of that event for future anaphoric reference. Perhaps we can reason our way to an interpretation of (2.2a,2.2b), but the process seems to be a laboured one, and we are left with the feeling that the speaker has not been cooperative in the Gricean sense. One can imagine the hearer's response to (2.2a,2.2b) being "When?".

2.3 The Distinction Between Events and Times

An intuitively appealing way of expressing these observations is to make a distinction between **events** and **times**. This would involve saying that (2.1a) makes reference to both an **event** and a **time**. The time can be referred to anaphorically by 'then' in (2.1b). However, (2.2a) introduces an **event** but not a **time**, and this makes 'then' inappropriate.

The problem with this is that we have not defined what we mean by an **event** and a **time**. We need at least an informal definition of this distinction if our account of 'then' is to be explanatory. One way we might do this is as follows:

Informal definition:

> An **event** is associated uniquely with a corresponding predicate or relation, one or more participants, and a time.[3] A **time**, on the other hand, is an instant or interval on some scale of measurement often referred to as the timeline. We do not think of times as being uniquely associated with participants and relations.

Although the above characterisation is an informal one, it goes some way towards identifying the concepts we have in mind when we use the terms 'event' and 'time'.

The distinction referred to above needs to be made in whatever semantic framework we choose to operate. First, however, we need to be clear as to what extent, if at all, the distinction has been made in previous work.

Montague (1973) represents time "instants" using the temporal index 't', and does

[3]We will be more precise later about exactly how events relate to times.

not consider events as such. Montague (1974)) discusses how to treat events and proposes that they be regarded as properties of times. Thus events are not given the status of basic entities in his theory, and the distinction between events and times in the sense we are using it does not apply there.

In the neo-Davidsonian approach adopted in (Parsons 1990), events are taken as primitives of the theory, and verbs are considered to stand for "kinds of events". E.g., use of the verb 'hit' means that the event described is a "hitting" event. Time is regarded as a property of events — e.g., the expression **cul(e,t)** means that the event **e** culminates at time **t**. In his treatment of tense and temporal reference, Parsons expresses temporal relations between **times** but not between **events**, thus making a clear distinction between the two. However, he does not cover temporal anaphora, so the distinction is not made for the reasons we give.

In early work on temporal reference in DRT, Partee (1984) and Hinrichs (1986) both use **event entities** rather than **temporal entities** in order to express temporal relations. Partee does not appear to consider this choice particularly significant. She explains how the two may be regarded as in some sense interchangeable (Partee 1984, p.255), employing Kamp's proposal that times may be "reconstructed" from events in the manner described in (Kamp 1979).

In more recent work on temporal reference in DRT, both temporal entities and event entities have been used. For example, Ogihara (1990) employs a system of three "reference times" to express the temporal relations corresponding to various English tenses. These reference times are temporal entities in the universe of discourse, and Ogihara expresses temporal relations between them and event entities. However, there are no temporal adverbials and no direct reference to "times" in his fragment. Thus, although there are "times" in the discourse representation structure (DRS), there is no notion of these times being referred to. Hence, Ogihara does not make the distinction between event entities and temporal entities for the reasons we have argued, and the distinction does not seem to have any particular significance in his approach. In later work, Ogihara (1991) extends his fragment to include temporal adverbials. He continues to introduce both event entities and temporal entities into the DRS, again without apparently attaching any significance to this distinction.

Eberle and Kasper (1991), in their analysis of tense and aspect in English and

French, also employ both events and times in the DRS, without comment on the distinction.

Kamp and Reyle similarly use both events and times in their treatment of temporal reference in DRT (Kamp and Reyle 1993) without attaching any theoretical significance to the distinction. In Section 2.10 we present our modification of Kamp and Reyle's temporal fragment, which incorporates our analysis of 'then'.

Work by Lascarides and Asher (1991) on temporal reference in a DRT framework also uses both event entities and temporal entities, but not in a way that corresponds with our observations on 'then'.

So we see that, although recent DRT treatments of temporal reference have employed both event entities and temporal entities (in contrast to earlier DRT treatments where only event entities were used), it appears that no principled distinction is being made between them — or, at least, no authors are explicit about their reasons for making the distinction. In contrast, our analysis of 'then' suggests that there is a principled reason for making the distinction between events and times. In particular, it justifies restricting the conditions under which temporal entities can be introduced into the universe of discourse.

An interesting question raised by this discussion is that of whether all these authors are referring to the same thing when they talk about events on the one hand and times on the other. This question is very difficult to answer. One way to address it is to examine what use they make of what they call 'event referents' and 'time referents'. Some differences can be identified here, as discussed above. Thus it seems that they are not using the terms in exactly the same way. However, this does not weaken our claim that none of these authors make a distinction among discourse referents between those that can be referred to anaphorically by 'then' and those that can't. This is our main point, irrespective of whether or not they are all using the terms in exactly the same way.

One way of expressing our observations about 'then' would be to say that sentence (1a) establishes a **temporal entity** in the current discourse representation structure (DRS), which is subsequently available for anaphoric reference by 'then'. Such a temporal entity might be regarded as being in some ways equivalent to the other types of discourse entities used in DRT to model pronominal anaphora.

We would expect, for example, an event entity to be established by (2.4a). This is shown by the acceptability of (2.4a,2.4b).

(2.4) a. Gareth climbed Ben Nevis
b. It surprised all his friends

'It' in (2.4b) presumably refers to the event of climbing Ben Nevis. Thus, (2.4a) makes available an event entity but not a temporal entity for future anaphoric reference. If it were possible for temporal entities to be constructed from event entities in the way that Partee (1984), following Kamp (1979), suggests, then surely we could construct a temporal entity from the event entity, and have no trouble in getting a cotemporal reading for (2.2a,2.2b).

So it becomes clear that a distinction must be made between temporal entities and event entities, and we will need to decide what conditions license the establishment of the former. The evidence that we have considered so far suggests that an **explicit temporal referent**, in the form of a temporal frame adverbial or an 'at'-adverbial, is required in order to establish a temporal referent. We will shortly examine this suggestion more thoroughly, in particular by considering Vendler classes other than accomplishments. Before doing so, we will look at some interesting parallels between the temporal entity / event entity distinction and the difference between **individual anaphora** and **role anaphora**.

2.4 Parallels with Role Anaphora and Individual Anaphora

Although the temporal entity / event entity distinction seems a reasonably intuitive one to make, it is important to explore what it means for events to have temporal relations expressed between them. We will shortly see what the notions of individual anaphora and role anaphora can offer us in this respect.

Note first that (2.2a,2.2b) and (2.2a,2.2c) sound unacceptable in a way that is very similar to the unacceptability of (2.5a,2.5b).

(2.5) a. Emily has a new coat
b. Fiona's coat is that colour

The sequence (2.5a,2.5b) sounds odd unless we already have a particular colour in mind — one that was either established earlier in the discourse or is somehow present in the context (visible to both speaker and hearer, say). Thus, it appears that mention of an object (a coat) in (2.5a) does **not** automatically make available the colour attribute of the coat for future anaphoric reference. Just as in the case of the temporal example (2.2a,2.2b), it seems possible for us to reason our way to an interpretation of (2.5a,2.5b), but the process is difficult, and we are again left with the feeling that the speaker has not been cooperative. The hearer's response to (2.5a,2.5b) might well be "What colour?" just as her response to (2.2a,2.2b) was "When?" We see a clear parallel here with the temporal examples discussed in the previous section.

Observe that it is possible to follow (2.5a) with (2.5c):

(2.5) c. The colour is blue

and that (2.5a,2.5c) may be followed by (2.5b). We can explain this in terms of the distinction between **individual** anaphora and **role** anaphora discussed in the psycholinguistics and AI literature. See (Garrod and Sanford 1990) for discussion. Individual anaphora involves explicitly mentioned entities which are subsequently available for anaphoric reference by **pronouns**. Role anaphora involves entities which are not explicitly mentioned but can nevertheless be referred to (using a definite noun phrase) by the succeeding discourse.

An example of individual anaphora is in the sequence:

(2.6) a. John bought a new car
b. It is a BMW

where the pronoun 'it' co-refers with the NP 'a new car'. An example of role anaphora given by Garrod and Sanford is:

(2.7) a. John drove to London

b. The car broke down on the motorway

where 'the car' clearly refers to the car that John drove to London, although a car is not explicitly mentioned in the first sentence. What appears to happen is that mentioning a 'drive' makes available a role 'the car' associated with the verb 'drive'. It is not possible to follow (2.7a) directly with:

(2.7) c. It is a BMW

but once the role has been explicitly focused by referring to 'the car' in (2.7b), the role attains the status of an individual and can subsequently be referred to by the pronoun 'it'.[4] Thus, on this account, (2.5a,2.5c) is acceptable because the definite NP 'the colour' in (2.5c) is picking out the "colour" role of the coat.

Let us consider how this analysis could be applied to the temporal entity / event entity distinction we drew above. We could say that the explicit mention of a "time" (e.g., by a temporal frame adverbial or an 'at'-adverbial) creates a **time individual**. Suppose we regard this as corresponding to a DRT temporal referent. Such an entity/referent appears to be available for subsequent reference by 'then', just as **nominal referents** are available for pronominal anaphora.

By contrast, mentioning an "event" (with no explicit reference to its time) makes available a **time role** associated with that event. We would expect to be able to refer to this time role using a definite NP, as in the non-temporal examples. For instance, we can say:

(2.8) a. Daniel climbed Ben Nevis

b. The month was July

[4]It is interesting to note that from (2.7a) we cannot infer that the particular role 'car' is available. For example John could have driven a bus. It seems that all we can infer from (2.7a) is the involvement of some "vehicle". This is in contrast to (2.5a), from which we can infer that a 'colour' role is present — because a material object must have a colour. However this distinction does not seem to affect the way in which we can refer to these roles.

and we can follow (2.8a,2.8b) with:

(2.8) c. Gareth climbed Snowdon then

whereas we have already seen that (2.8a) cannot be followed directly by (2.8c). What seems to be happening here is that 'the month' in (2.8b) is picking out a time role, thereby giving it the status of a time individual, so that it can henceforth be referred to by 'then'.

We can construct a similar example where 'the time' seems to pick out the time role associated with an event, as in:

(2.9) a. Daniel reached the summit

b. The time was 5pm

We might expect the phrase 'at the time' to behave in a similar manner. It may thus be surprising to note that the sequence:

(2.10) a. Daniel climbed Ben Nevis

b. Gareth climbed Snowdon at the time

is not acceptable. 'At the time' shows the same behaviour as 'then' in this respect.[5]

Why is it not possible to use 'at the time' in (2.10b) to refer to the time role associated with the event in (2.10a)? We will offer an explanation for this after broadening the scope of our analysis of 'then' beyond **accomplishments** to the other aspectual classes.

[5]The reader may have noticed that 'at the same time' behaves differently from 'at the time'. This is considered further in Section 2.6. For a detailed analysis of 'at the time' and 'at the same time' see Chapter 4.

2.5 Extending the Analysis of 'then' to the Other Aspectual Classes

In Sections 2.1–2.3 we drew a distinction between the **cotemporal** use of 'then', which requires a previously-established explicit temporal referent, and the **update** use of 'then' which does not. We saw that sentence-initial 'then' normally (or perhaps always) has the update function, whereas sentence-final 'then' is often (but not always) cotemporal. Our analysis up to this point has been restricted to accomplishment sentences.

Now we turn our attention to a range of examples involving statives.[6] Some of the following observations about sentence-final 'then' with statives have also been reported recently in (Spejewski and Carlson 1993) and (Schiffrin 1992). We will discuss these accounts and how they relate to the work reported here in Section 2.8.

First, consider the following:

(2.11) a. Gareth climbed Everest
b. He was happy then, battling against the elements

The above sequence is perfectly acceptable, and the latter part of (2.11b) makes it clear that Gareth's happy state can be interpreted as cotemporal with the climbing event.[7]

So here we have an example of cotemporal 'then' which does not need an ETR. Why should this be possible in (2.11a,2.11b) but not, as we saw earlier, in (2.2a,2.2b)? The obvious difference between (2.11b) and (2.2b) is that (2.11b) is a state whereas

[6]Note that we use the terminology of (Vendler 1967) in the following discussion.

[7]We do not necessarily have to interpret 'then' cotemporally in this type of example. It is possible to follow (2.11a) with (2.11c), for example.

(2.11) c. He was happy then, having achieved a lifelong ambition

where the latter part of (2.11c) forces the update reading. However our point is simply that the cotemporal reading is **possible** in (2.11a,2.11b), whereas it is not in (2.2a,2.2b).

(2.2b) is an accomplishment. Many examples like (2.11a,2.11b) can be constructed, where the 'then'-sentence contains a state and cotemporal 'then' is possible with no ETR. E.g.:

(2.12) a. John lived in London

b. He was unhappy then

and:

(2.13) a. John taught Fred to swim

b. Fred was a boy then

In the latter sequence it is clear that the temporal relation being expressed is one of temporal inclusion (of the event in (2.13a) by the state in (2.13b)) rather than one of cotemporality. The state acts in some way as a background for the event. Because of this, it is perhaps better to refer to 'cotemporal/background 'then' ' rather than 'cotemporal 'then' '.

The notion of a state acting as 'background' to an event is one that we will develop further as this chapter proceeds. In Chapter 4, we will give a formal definition of the discourse relation **backgrounding**. Here, we will start by identifying backgrounding with temporal inclusion.

Informal Definition:

> We will say that an eventuality e_1 'acts as background to' or 'backgrounds' an eventuality e_2 if e_1 temporally includes e_2 and if e_1 is stative and e_1 is non-stative. This latter requirement is in order to distinguish 'background' from 'elaboration' (see below), which also involves temporal inclusion.

We will say much more about backgrounding, events and states in Chapter 4.

We need to ask why it is that states behave differently from events in this respect. A line of investigation that suggests itself is to look at some Vendler **activities** (known in the accounts of several others as 'processes' — the term we will use from now on), which can be thought of as intermediate between states and accomplishments.

Consider:

(2.14) a. Daniel played football
 b. Owen swam in the pool then

We judge sequence (2.14a,2.14b) to hover on the verge of acceptability. Notice how much better (2.14a,2.14c) sounds:

(2.14) c. Owen was swimming in the pool then

Presumably this is because (2.14c) is a progressive — a construction regarded by many as stative (see Carlson 1977, Vlach 1981 and Moens 1987, for example).

We suggest that (2.14a,2.14b) sounds acceptable to the extent that we can regard (2.14b) as describing a state rather than an event — and can thus see the state as a **background** to the event. So we see that processes appear to lie somewhere between states and accomplishments as regards 'then'. States allow cotemporal/background 'then' with no ETR; accomplishments do not. Processes occupy some middle ground between the two.

One distinction between states and events which may be relevant here involves the notion of "temporal updating" (by which we mean the forward movement of narrative time which is often induced by sequences of telic events). Let us consider how the different Vendler classes behave as far as updating is concerned.

Hinrichs (1986) made the following claims about sequences of sentences in the simple past tense:

1. If both sentences are accomplishments/achievements we get updating.
2. If either sentence is a process or a state the sequence can be either updating or temporally overlapping.

3. If both sentences are processes/states, the sequence is temporally overlapping.

It is not difficult to think of exceptions to Hinrichs' proposed "updating" rule for accomplishment/achievement sequences. A sequence of two telic events need not be interpreted as updating if, for example, the second event can be seen as some kind of elaboration of the first. However, (1) might still be seen as a "default" rule which applies in the absence of world knowledge mitigating against the update.[8]

Possible interpretations for an event-event sequence include:

- A list of events, in which nothing is conveyed about the temporal order of those events.
- A sequence of events occurring in the order of presentation.
- A single event, with subsequent "elaborations" of it, which may provide further information about the event as a whole, or may pick out a single part of it.

Any of these interpretations may be ruled out by world knowledge.

Although Hinrichs' first statement is not true without exception, his second statement, which says that if either sentence is a process or a state then the sequence can be either updating or temporally overlapping, appears correct. It simply allows the possibility of a non-update reading if one of the sentences is not a telic event.

Here we have a potential explanation for cotemporal/backgrounding 'then' being acceptable without an ETR for a stative 'then' sentence but not for a non-stative one. Let us look for a moment at the possible interpretations of the sequences *with 'then' removed.* If the second sentence is a state, we *need not* update — thus we can read:

[8]Recent work by Caenepeel and Moens (1994) suggests that the notion of temporal updating for event-event sequences should be restricted to a particular type of context, namely "narrative context". This excludes non-narrative intepretations such as temporally unordered lists, elaborations of the same event, etc.

(2.15) a. John lived in London
b. He was unhappy

as non-updating. Correspondingly, the sequence (2.15a,2.15c):

(2.15) c. He was unhappy then

is acceptable, and 'then' gets its cotemporal/background meaning. Similarly the sequence:

(2.16) a. Gareth climbed Everest
b. He was happy

is not *necessarily* updating — and (2.16a,2.16c):

(2.16) c. He was happy then

is acceptable for cotemporal/background 'then'. However the telic event sequence:

(2.17) a. Daniel climbed Ben Nevis
b. Gareth climbed Snowdon

may allow, we have said, a "list" reading, an "update" reading or an "elaboration" reading. It seems that we may eliminate the elaboration reading because world knowledge makes it very unlikely. This leaves us with the list and the update readings for the sequence. The important point is that a background/cotemporal interpretation is *not* available.

Now suppose we add 'then' to (2.17b), to give:

(2.17) c. Gareth climbed Snowdon then

The presence of 'then' seems to rule out the "unordered list" interpretation, because by introducing 'then' we are making some claim about the times of the events. This leaves us with only the update interpretation. We suggest that it is the absence of a background/cotemporal interpretation which precludes the interpretation of 'then' as referring to the time of the event in (2.17a). The availability of a background/cotemporal interpretation of the sequence is the crucial criterion for the possibility of 'then' referring to the time of the event in the first sentence.

The background/cotemporal criterion also accounts for the borderline cases involving processes. Processes can be interpreted as updating or not, depending on contextual factors.

E.g.:

(2.18) a. Daniel played football
b. Owen swam in the pool

Here, the swimming event could be regarded as occurring after the playing event, or as cotemporal (or temporally overlapping) with it — or the times could be irrelevant. The possibility of (just about) being able to interpret the sequence as a background/cotemporal one explains why:

(2.18) a. Daniel played football
c. Owen swam in the pool then

is (just about) acceptable. Now let us consider an example with achievements:

(2.19) a. Daniel reached the summit of Ben Nevis
b. Gareth reached the summit of Snowdon then

The sequence (2.19a,2.19b) is unacceptable in what seems to be the same way as the sequence (2.2a,2.2b) involving accomplishments. This is what we would expect, given that achievement-achievement sequences give rise to temporal updating in narrative discourse. Consider, however, the sequence (2.19a,2.19c):

(2.19) c. He achieved his ambition then

This sequence is acceptable. Why should this be, and what makes the difference between (2.19a,2.19b) and (2.19a,2.19c)? What distinguishes the sequences (2.19a,2.19b) and (2.19a,2.19c) is that (2.19a,2.19b) must be read as involving two **separate events**, whereas (2.19a,2.19c) can be read as two descriptions of the **same event**.[9]

But of course this ties in with the update/non-update distinction. If we read (2.19c) as referring to the same event as (2.19a), then there is no updating — (2.19c) is simply an elaboration of (2.19a). The fact that there is no updating explains in turn the possibility of 'then' referring to the time of the event in (2.19a). Cotemporal 'then' is acceptable because a non-update reading is available. It is also interesting to note that if we say:

(2.20) a. Daniel reached the summit of Ben Nevis on Saturday
b. He achieved his ambition then

we interpret 'then' as referring to the event time in (2.20a), rather than to the ETR 'on Saturday'. Similarly, in the sequence:

(2.21) a. Emily went to the zoo last week
b. She saw some flamingoes then

the natural interpretation is one in which we see 'then' as referring to the time of the event in (2.21a), not to 'last week'. Compare this with (2.21a,2.21c):

[9] We are using the term 'event' in an intuitive and non-technical sense here.

(2.21) c. Gareth climbed Snowdon then

where we interpret 'then' as referring to the ETR 'last week'. It seems clear that the different interpretations relate to our world knowledge about the possible connections between events. We readily see the event in (2.20b) as being a part of the event in (2.20a) (i.e., as an elaboration of (2.20a)). Similarly, we readily see (2.21b) as an elaboration of (2.21a). However, it is next to impossible to see (2.21c) as an elaboration of (2.21a). Note too that the sequence:

(2.22) a. Emily went to the zoo
 b. She saw some flamingoes then

is (at least marginally) acceptable, even though there is no ETR. Although the degree of acceptability of (2.22a,2.22b) may be disputed, it is undoubtedly more acceptable than (2.2a,2.2b).

It appears, then, that we must view elaborative sequences as some kind of special case. We can account for the (near) acceptability of (2.22a,2.22b) using a similar explanation to the one we gave for (2.19a,2.19c).[10] We readily perceive the event in (2.22b) as a sub-event of the event in (2.22a).[11] So no temporal updating takes place between (2.22a) and (2.22b), and it is therefore possible to interpret 'then' in (2.22b) as referring to the time of the event in (2.22a).

The fact that 'then' in (2.22b) refers to the time of the event in (2.22a) explains why (2.21a,2.21b) has a reading where 'then' refers not to the ETR 'last week' but to the time of the event in (2.21a). However, this does not explain why the ETR reading for (2.21a,2.21b) is not readily available. But perhaps we can rely on world knowledge and context to do this for us. Indeed, it is easy to construct parallel examples where the ETR reading clearly *is* available. For instance:

[10]Although we have not explained why (2.22a,2.22b) is, at least for some speakers, only marginally acceptable.

[11]It is interesting to consider why this is so, although we will not investigate the matter further here. Of course world knowledge is involved, and will influence which events can readily be seen as forming parts of other events. Discourse context and background information will have an effect here, too. It seems probable that we get other clues from the form of the discourse, including factors like the repetition of pronouns (as in (2.22a,2.22b)).

(2.23) a. John went to France last month

b. Mary crashed her car then

In (2.23a,2.23b), both the ETR and the non-ETR readings can be obtained, with context presumably favouring one or the other. For example, if the hearer knew that Mary was on holiday with John in France, this knowledge might well favour the non-ETR reading. On the other hand, if there were no known connection between the two events, the ETR reading would become easier to obtain.

So we see that, in principle, both readings are available in this type of example. This leads us to posit an ambiguity in the interpretation of sentence-final 'then' in cases where both the ETR and the non-ETR readings are available.

Let us summarise our observations so far. We have identified a three-way distinction in uses of 'then'.

1. The use in which 'then' is anaphoric to a previously established explicit temporal referent.
2. The update use.
3. The cotemporal/background use.

(1) occurs where an explicit temporal referent, established earlier in the discourse, is available. Temporal frame adverbials and 'at'-adverbials may both establish such a referent.

(2) occurs in cases where, if 'then' were removed from the second sentence, the sequence would be interpreted as non-backgrounding. The update reading is often difficult or impossible to get for sentence-final 'then', which predisposes the cotemporal/background reading. Thus, sequences which cannot be interpreted as background/cotemporal (or elaborative — see (3) below) sound odd with sentence-final 'then', unless the presence of an explicit temporal referent makes interpretation (1) possible.

(3) occurs in cases where, if 'then' were removed from the second sentence, the sequence would be interpreted as non-updating (e.g., the second sentence has a background or elaborative role with respect to the first).

Let us group (2) and (3) together and refer to their union as the use of 'then' which is responsible for expressing **temporal relations** between eventualities.[12] Such temporal relations can involve cotemporality, precedence, temporal overlap and so on.

By contrast, we could refer to (1) as the use of 'then' as a **temporal anaphor**.

This gives us a two-way distinction, between:

1. The use of 'then' as a **temporal anaphor** referring back to a previously established ETR.
2. The use of 'then' as a means of expressing **temporal relations between eventualities**.

Having clarified this distinction, we are in a position to return to our discussion of role anaphora in Section 2.4. We show below how we can now explain why 'then' and 'at the time' cannot always refer to time roles in the way we might expect. Our explanation will employ a relation between events and states which we call the PART-OF relation, to be explained shortly.

2.6 Role Anaphora and the PART-OF Relation

Suppose we have an updating sequence such as:

(2.24) a. Daniel climbed Ben Nevis
b. Gareth climbed Snowdon

We have seen that adding sentence-final 'then' to (2.24b) to give the sequence (2.24a,2.24c) is not acceptable.

(2.24) c. Gareth climbed Snowdon then

[12]We use this term to cover 'events' and 'states', as in (Bach 1986).

This was explained in terms of sentence-final 'then' (with no ETR present) giving the background/cotemporal reading, which "clashes" with the updating nature of the sequence of events. By contrast, the sequence (2.24a,2.24d):

(2.24) d. Gareth was climbing Snowdon then

is acceptable because of the non-updating nature of the sequence:

(2.24) a. Daniel climbed Ben Nevis
e. Gareth was climbing Snowdon

We discussed in Section 2.4 the parallel between this use of 'then' (expressing temporal relations between events) and **role anaphora**. In order to pick out a **role** in role anaphora, a definite NP is used. Thus, we might expect 'at the time' to pick out a time role. However, we noted that:

(2.24) a. Daniel climbed Ben Nevis
f. Gareth climbed Snowdon at the time

is unacceptable, as is (2.24a,2.24c), whereas (2.24a,2.24g):

(2.24) g. Gareth was climbing Snowdon at the time

is acceptable, as is (2.24a,2.24d). Thus 'then' and 'at the time' behave identically in this respect.[13] But why is their ability to pick out time roles restricted in this way?

From now on, we will adopt the abbreviations 'SI-'then' ' for sentence-initial 'then', and 'SF-'then' ' for sentence-final 'then'. Also, we ignore from this point

[13]We also noted in Section 2.2 that the behaviour of 'at that time' is similar to that of 'at the time'. This observation seems to merit further study, but we do not consider 'at that time' further here.

in the discussion the ETR use of SF-'then', so that when we speak of SF-'then' as acceptable or otherwise, we refer to its non-ETR use only. Finally, let us refer to the non-ETR use of 'then' as the PART-OF use.

We have already seen that if the eventuality described by the second sentence has a **background** or **elaborative** function (i.e., it is non-updating) with respect to that described by the first sentence, 'at the time' and SF-'then' are both acceptable. If, on the other hand, the second sentence is **updating** with respect to the first, 'at the time' and SF-'then' are not acceptable.

What makes the difference between updating and non-updating sequences? We saw earlier that what is going on involves the hearer being able to infer a time role from the mention of an eventuality. In some cases, 'then' or 'at the time' may be used to pick out the time role, and in some cases this is not possible.

We propose that the difference between what we have been calling updating and non-updating sequences is in fact a more fundamental distinction, involving whether or not one eventuality can be seen as part of another eventuality. In this chapter, we will simply introduce an intuitive relation PART-OF which is not made formally precise but which is intended to cover (at least) the notions of **backgrounding** and **elaboration**. In Chapter 3, when we develop a situation theoretic fragment, we will make the PART-OF relation precise by identifying it with situation theoretic PART-OF ($\trianglelefteq$), which holds between situations and is defined in terms of infon support.

Now consider again a sequence of two sentences, each of which describes an eventuality. We propose that if the second sentence is in a background or elaboration relation to the first, the eventuality described by the second sentence is PART-OF the eventuality described by the first. Thus in (2.25a,2.25b):

(2.25) a. Daniel climbed Ben Nevis
b. He was happy

the state s_2 described by (2.25b) is PART-OF the event e_1 described by (2.25a). Similarly, for an elaborative sequence:

(2.26) a. Daniel went to the zoo

b. He photographed some penguins

we can say:

e_2 PART-OF e_1

where e_1 is the event described by (2.26a) and e_2 is the event described by (2.26b).

Now consider a sequence where the relation between the sentences is neither background nor elaboration.

(2.25)	a.	Daniel climbed Ben Nevis	(e_1)
	c.	Gareth climbed Snowdon	(e_2)

Here we would want to say that

$\neg(e_2$ PART-OF $e_1)$

That is, e_2 is described as a separate event from e_1.[14]

To make our proposal clearer and show how it could be incorporated into a DRT analysis, we will now present DRSs corresponding to the three sequences discussed above. Using Kamp and Reyle's notation for DRSs, we can draw the DRS for (2.25a,2.25b) as:

$$\begin{array}{|l|}\hline \quad e_1\ s_2\ u\ v \\ \hline \\ \text{Daniel}(u) \\ \text{Ben Nevis}(v) \\ e_1\text{:}\ \boxed{u\ \text{climb}\ v} \\ \\ s_2\text{:}\ \boxed{\text{happy}(u)} \\ s_2\ \text{PART-OF}\ e_1 \\ \\ \hline \end{array}$$

[14]Of course, that is not to say that if (2.25a,2.25c) were embedded in some larger piece of discourse, e_1 and e_2 could not be seen as both being part of some bigger situation/event.

Note that we do not allow either sentence to introduce a **temporal** discourse referent. This is because neither sentence contains a temporal adverbial, and we argued earlier that temporal referents may only be introduced by a temporal adverbial of appropriate type.

It should be noted, too, that when we analyse 'at the time' in Chapter 4 we will develop a refined definition of backgrounding, where the backgrounding eventuality does *not* correspond to a new situation (in the situation-theoretic sense — see Chapter 3), but instead adds more information to the situation described by the previous sentence. This is different from our account here, where we treat backgrounding as an instance of the PART-OF relation. At this point, we have no way of getting to the Chapter 4 conclusion, firstly because this is based on the analysis of 'at the time', and secondly because we have not yet introduced a formal notion of situation. Our conclusions here about backgrounding should therefore be seen as provisional. The findings of Chapter 4 will not overturn the general conclusion that what we have called PART-OF 'then' conveys either an elaboration or a background relation. All that will change is our way of characterising the background relation.

It will be observed that we have not directly expressed any temporal relation between e_1 and s_2. Information about temporal relations is seen as only implicitly present. It is possible for the hearer to infer various pieces of information from the information in the DRS above. She may infer that there is a time role t_1 associated with e_1, and a time role t_2 associated with s_2. In addition, she may infer information about the temporal relation between t_1 and t_2. But the important point is that such information is not directly expressed by the utterance, and should not, for reasons argued earlier, go into the DRS. Thus, we are advocating making a clear distinction between information directly conveyed by a statement (**described information**, in situation theoretic terms), and information inferred by the hearer (**carried** or **inferred information**, in situation theoretic terms).

We will be making use of the distinction between described and inferred information a great deal in what follows. At this stage, a useful way to envisage the distinction is to see **described** information as information that cnnot be overridden or cancelled by a later statement without the speaker making it clear that she is "going back on" what was previously said. **Inferred** information, on the other hand, can be seen as information derived by the hearer in addition to the information that was explicitly given by the statement. Such inferences, can, at least in principle, be cancelled by a later statement. We will see in Chapter 5 how such inferences can be made by means of channels and constraints, using the channel theoretic notions of (Barwise and Seligman in press).

It is interesting to note that this analysis also covers the reading of (2.25a,2.25b) where Daniel becomes happy *after* climbing Ben Nevis — that is, his happiness is a result of his climb. But notice that this is just another way that the state can be seen as part of the total or compound event. In other words, (2.25a,2.25b) on this reading describe a compound event e_1, of which s_2 is a part. The compound event comprises the climb and what we might call, in the terminology of Moens and Steedman (1988), its consequent state. This concurs with Moens and Steedman's proposed nucleus structure for events, where an event consists of a preparatory process, a culmination and a consequent state. And because our DRS says nothing about temporal relations, but merely allows us to infer them, this DRS covers both readings of (2.25a,2.25b). Information about whether s_2 follows e_1 or overlaps with it is merely inferred information. Which of the alternative inferences the hearer makes will depend on context and world knowledge.

For (2.26a,2.26b) we require the DRS:

$$\begin{array}{|l|}\hline \quad e_1\ e_2\ u\ v\ w \\ \hline \text{Daniel}(u) \\ \text{zoo}(v) \\ e_1\text{: } \boxed{\text{u go-to v}} \\ \text{penguins}(w) \\ e_2\text{: } \boxed{\text{u photograph w}} \\ e_2 \text{ PART-OF } e_1 \\ \hline \end{array}$$

(No attempt is made here to deal with the semantics of the quantifier 'some', the plural 'penguins', the determiner 'the', the preposition 'to' or the past tense, none of which are relevant to our present purposes.)

Finally, for (2.25a,2.25c) we require:

$$\begin{array}{|l|}\hline \quad e_1\ e_2\ \mathrm{u\ v\ w\ x} \\ \hline \\ \quad \text{Daniel(u)} \\ \quad \text{Ben Nevis(v)} \\ \quad e_1\text{: } \boxed{\text{u climb v}} \\ \quad \text{Gareth(w)} \\ \quad \text{Snowdon(x)} \\ \quad e_2\text{: } \boxed{\text{w climb x}} \\ \quad \neg(e_2 \text{ PART-OF } e_1) \\ \\ \hline \end{array}$$

Here, the PART-OF relation is explicitly stated not to hold between e_1 and e_2. We will see the motivation for this shortly, when we turn to 'then', 'at the time' and 'at the same time'.

How does this help us with 'then'? Suppose we restrict the (non-ETR) use of SF-'then' to cases where the second eventuality can be seen as part of the first. This would explain why we can add 'then' to (2.25b) in (2.25a,2.25b) and to (2.26b) in (2.26a,2.26b), but not to (2.25c) in (2.25a,2.25c). We could restrict the distribution of 'at the time', which we noted appears to behave similarly to (non-ETR) 'then', in exactly the same way.[15]

In other words, we are claiming that (non-ETR) SF-'then' expresses a discourse relation between two eventualities, namely that the second eventuality is a part of the first. But the nature of the sequence must make the PART-OF relation possible. It appears to be possible if the second eventuality can be seen as being in a background relation or an elaboration relation to the first. The former is made possible, it appears, if the second eventuality is a state (or a progressive, which as we have already noted has often been characterised in the literature as a state). The elaboration relation requires supportive context or world knowledge.

We can also explain the distribution of 'at the same time' this way. We remarked earlier that this expression behaves differently from 'then'. Note that:

(2.25) a. Daniel climbed Ben Nevis

[15]Except that, for some reason, 'at the time' appears not to be completely acceptable after (2.26b). In general, we note that 'at the time' appears not to be felicitous after an elaborative sequence. We will discuss this further below and in Chapter 4.

can be followed by:

(2.25) d. Gareth climbed Snowdon at the same time

That is, 'at the same time' is acceptable in a sequence where 'then' (and 'at the time') are not. Note also that:

(2.25) a. Daniel climbed Ben Nevis
e. Gareth was a boy at the same time

is not acceptable. These observations suggest that 'at the same time' is in complementary distribution with the PART-OF reading of 'then'. Suppose we say that in order to add 'at the same time' to the second sentence of a sequence, it is required that the second eventuality is *not* a part of the first. This allows us to explain why (2.25a,2.25d) is acceptable but (2.25a,2.25e) is not. It does not seem possible to see the relation between (2.25a) and (2.25e) as anything other than background. Thus we are forced to see the state in (2.25e) as part of the event in (2.25a) — and 'at the same time' is therefore inconsistent.

The case of (2.26a,2.26b) is interesting.

(2.26) a. Daniel went to the zoo
b. He photographed some penguins

Here, it is possible to add 'at the same time' to (2.26b), but there is an intuition that by so doing we are forced into seeing (2.26a) and (2.26b) as describing "separate" events. This fits well with the proposal that 'at the same time' is only allowed in cases where the second eventuality is not part of the first. We can also explain why:

(2.25) a. Daniel climbed Ben Nevis

can be followed by either:

(2.25) f. Gareth was climbing Snowdon then

or:

(2.25) g. Gareth was climbing Snowdon at the same time

We do this by supposing that the progressive may convey either a background or a non-background relation. If the relation is background, then the second eventuality is part of the first, making 'then' appropriate and ruling out 'at the same time'. If, on the other hand, the relation is non-background (and there is no reason to infer an elaboration reading), the second eventuality is not part of the first, which rules out 'then' and makes 'at the same time' appropriate. This explanation is supported by the intuition that in (2.25a,2.25d), Gareth's climb goes on for much longer than Daniel's, while in (2.25a,2.25e) the two climbs may well occupy comparable amounts of time. A more detailed account of 'at the same time' with the progressive will be given in Chapter 4.

Before we move on we will briefly discuss the distribution of 'at the time'. Again, a fuller account will be given in Chapter 4.

We noted in Section 2.2 that (2.2a,2.2d), repeated here as (2.25a,2.25h), is not acceptable.

(2.25) a. Daniel climbed Ben Nevis
h. Gareth climbed Snowdon at the time

We noted too that (2.27a,2.27b) is unacceptable.

(2.27) a. Daniel climbed Ben Nevis in July
b. Gareth climbed Snowdon at the time

This latter observation shows that 'at the time' does not have a reading corresponding to the ETR reading of 'then'. But it behaves like 'then' in (2.25a,2.25f) by being unacceptable in a case where the PART-OF relation does not hold. This suggests that perhaps 'at the time' has the same semantics as PART-OF 'then', i.e. that it conveys a PART-OF relation between the two eventualities.

In order to check this, let us see how 'at the time' behaves with an elaborative sequence.

(2.28) a. Emily went to the zoo
b. She photographed some penguins at the time

(2.28a,2.28b) sounds odd, whereas the corresponding sequence with 'then' as we saw earlier, is acceptable. Thus it appears that 'at the time' does not convey an elaboration relation, but is only acceptable where the relation is one of backgrounding. We will consider this further in Chapter 4.

Now let us look briefly at sentence-initial 'then' (which we will abbreviate to SI-'then'). We noted earlier that SI-'then' appears always to cause updating — i.e., to convey that the first eventuality temporally precedes the second. In order to explain this, we propose that SI-'then' imposes the requirement that the second eventuality is not part of the first, and, in addition, that the first eventuality temporally precedes the second. This analysis is supported by examples such as:

(2.29) a. John pushed Peter
b. Peter fell

as compared with:

(2.29) a. John pushed Peter
c. Then Peter fell

Sequence (2.29a,2.29b) readily invites us to infer that the pushing caused the falling. This is consistent that with the analysis that the second eventuality is part of the first — the fall is the consequence of the push. Introducing SI-'then' in (2.29c) makes this interpretation less likely by effectively saying that the fall is *not* part of the first eventuality. This is what removes the strong sense of consequence that is present in (2.29a,2.29b).

We also noted earlier that for some speakers:

(2.30) a. Daniel climbed Ben Nevis
b. Gareth climbed Snowdon then

is at least marginally acceptable on an update reading. We can explain this by proposing that SF-'then' can, with some difficulty, take on the function of SI-'then' characterized above.

The analysis we give for SI-'then' appears satisfactory for the examples we have investigated. However, the primary purpose of this chapter is to investigate SF-'then', and we have not looked at SI-'then' in anything like the same detail. Therefore we offer our analysis of SI-'then' more tentatively than our analysis of SF-'then'.

Finally, we should point out that the PART-OF analysis is also supported by the examples in Section 2.5, which we discussed in terms of an intuitive notion of events being part of other events.

An independently-developed account that has some interesting similarities with our PART-OF proposal for sentence-final 'then' is given in by Spejewski and Carlson (1993). We discuss this in Section 2.8.

2.7 Examples

Let us at this point draw together the results of our analysis so far. Our overall proposal is that sentence-final 'then' is potentially ambiguous between two readings, which we call the ETR reading and the PART-OF reading. Each reading is only available under certain conditions, which are summarized below. If both sets of conditions are fulfilled, then both readings of 'then' are available, and the sequence is ambiguous.

The conditions for the two readings are as follows:

- ETR reading

  In order to get this reading, an ETR must be present in the discourse context. In the two-sentence sequences we have been looking at, the ETR must have been introduced by a temporal frame adverbial or 'at'-adverbial in the previous sentence. However, in a longer piece of discourse the ETR may well have been introduced by an earlier sentence. One possibility would be to impose the requirement that ETR 'then' refer to the most recently introduced ETR. However it is possible that this is not always the case, especially, perhaps, where embedded discourses are concerned. Further discussion of this would, however, take us well beyond the scope of this chapter.

- PART-OF reading

  The availability of this reading requires that the second eventuality be part of the first. This requirement is made formal by introducing the situation theoretic relation PART-OF. The condition is fulfilled at least in cases where the second eventuality is in a background or elaboration relation with the first. 'At the time' appears to require similar but not identical conditions (it is not acceptable with an elaboration relation).

We now show how this analysis works for the key examples we considered earlier. We give the DRS for each sequence, but we do not show at this point how these DRSs are derived. In Sections 2.10–2.11 we present a grammatical fragment and corresponding construction rules which produce the required DRSs, together with an explanation of how the derivation works in each case. Here, we merely present the results.

Turning to the sequence (2.31a,2.31b):

(2.31) a. Daniel climbed Ben Nevis in July
       b. Gareth climbed Snowdon then

we see that the conditions for the ETR reading are fulfilled — there is an ETR, introduced by the frame adverbial 'in July' in (2.31a). The requirements for the PART-OF reading, on the other hand, are not met, because the second eventuality cannot be seen as part of the first. (There is no background or elaboration reading.) Hence, only the ETR reading is available. We represent this as in the DRS below.

e_1 t_1 e_2 u v w x
Daniel(u) Ben Nevis(v) e_1: $\boxed{\text{u climb v}}$ $e_1 \sqsubseteq t_1$ july(t_1) Gareth(w) Snowdon(x) e_2: $\boxed{\text{w climb x}}$ $e_2 \sqsubseteq t_1$

The relation $\sqsubseteq$ holds between an eventuality and a time if the eventuality takes place within that time. The DRS expresses the information that Gareth's climb takes place within the time referred to by 'July'.

Now consider (2.32a,2.32b):

(2.32) a. Daniel climbed Ben Nevis

b. Gareth was climbing Snowdon then

Here, the conditions for the PART-OF reading but not those for the ETR reading are met. Thus only the PART-OF reading is available. The DRS is:[16]

[16]Note that here we analyse the progressive as stative. This is not important to our analysis and we are by no means committing ourselves to this analysis of the progressive. Our chief reason for doing it this way is because Kamp and Reyle (1993) treat progressives as statives, and our fragment is based on theirs. We present an alternative analysis of the progressive in (Glasbey 1994a).

e_1 s_2 u v w x
Daniel(u) Ben Nevis(v) e_1: $\boxed{\text{u climb v}}$ Gareth(w) Snowdon(x) s_2: $\boxed{\text{w PROG(climb) x}}$ s_2 PART-OF e_1

The above DRS expresses the PART-OF relation between eventualities, which we motivated earlier. Here, the second eventuality s_2 is related not to a time as in the previous example, but to an event. This brings out the symmetry in our analysis of the two uses of 'then': the ETR use involves a relation with a previously mentioned time, and the PART-OF use involves a relation with a previously mentioned event.

Now consider (2.33a,2.33b):

(2.33) a. Daniel climbed Ben Nevis
b. Gareth climbed Snowdon then

Here, neither set of conditions is met — there is no ETR, and no PART-OF relation. As a result, 'then' cannot have either an ETR or a PART-OF reading and no DRS can be constructed.

Finally, in the case of (2.34a,2.34b):

(2.34) a. Daniel climbed Ben Nevis in July
b. Gareth was climbing Snowdon then

both sets of conditions are fulfilled, and thus both the ETR and the PART-OF readings are available and the sequence is ambiguous. It can be interpreted either on the ETR reading (which states that Gareth's climb took place in July) or on the PART-OF reading (where Gareth's climb is in a background relation to

Daniel's climb). Of course, as we observed earlier, contextual information might well favour one interpretation or the other.

Perhaps we should point out here that the ETR reading does not say anything about the temporal relation between the two eventualities, other than what can be inferred from the frame adverbial. In other words, on the ETR interpretation for 'then', no information is given about the temporal ordering between the two eventualities.

Two DRSs may be obtained for (2.34a,2.34b), corresponding to the ETR and PART-OF readings respectively.

(1) ETR reading:

e_1 t_1 s_2 u v w x
Daniel(u) Ben Nevis(v) e_1: $\boxed{\text{u climb v}}$ $e_1 \sqsubseteq t_1$ july(t_1) Gareth(w) Snowdon(x) s_2: $\boxed{\text{w PROG(climb) x}}$ $s_2 \sqsubseteq t_1$

(2) PART-OF reading:

e_1 t_1 s_2 u v w x
Daniel(u) Ben Nevis(v) e_1: $\boxed{\text{u climb v}}$ $e_1 \sqsubseteq t_1$ july(t_1) Gareth(w) Snowdon(x) s_2: $\boxed{\text{w PROG(climb) x}}$ s_2 PART-OF e_1

2.8 Related Work on 'then'

Since we carried out our analysis of 'then', two recent accounts have appeared: those of Spejewski and Carlson (1993) and Schiffrin (1992), which cover some of the same ground. Both examine the contrast between sentence-initial and sentence-final 'then', point out the existence of sequential and cotemporal readings and discuss how these relate to the aspectual categories of the eventualities. Neither considers the way that 'then' behaves in relation to an explicit temporal referent. However, it is interesting to see that some similar conclusions to ours have been reached with regard to what we call PART-OF 'then'. We present a brief summary of the two accounts below.

2.8.1 Spejewski and Carlson's analysis of 'then'

Spejewski and Carlson (1993) identify three senses of 'then', these being:

1. Sequential
2. Cotemporal
3. Consequential

and choose to focus on the first two of these. They observe that sentence-initial 'then' predisposes a sequential reading and sentence-final 'then' a cotemporal reading, and show how these can be explained in terms of discourse relations between clauses. Two discourse relations are postulated, these being:

1. **Subordination ('daughter' relation)**. Here, one eventuality is temporally dependent on (or subordinate to) the other. Spejewski and Carlson include both what we have called 'background' and 'elaboration' relations in this. Thus, subordination is similar to what we have called the PART-OF relation.

2. **Temporal distinctness ('sister' relation)**. Here, there is no temporal dependency of one eventuality upon the other.

The authors show how 'then' serves to specify one or other of these discourse relations. Sentence-initial 'then' conveys the temporal distinctness / sister relation and rules out subordination. Sentence-final 'then' conveys subordination. The discourse relations are defined in terms of reference time intervals as used in (Partee 1984). However, unlike Partee, Spejewski and Carlson allow states to introduce new reference times of their own rather than continuing the reference time introduced by a previous event. They adopt the treatment of (Hinrichs 1986), where a state surrounds its reference interval, in contrast to an event, which is contained within its reference interval. This allows them to explain why sentence-final 'then' generally conveys temporal overlap.

Thus, Spejewski and Carlson's analysis is similar to our account of the PART-OF reading of 'then'. It is particularly interesting that they have also come up with a bipartite distinction between one discourse relation: 'subordination' and another one: 'distinct'.

2.8.2 Schiffrin's analysis of 'then'

Schiffrin (1992) identifies three distinct uses of 'then', which are:

1. Local anaphoric
2. Global anaphoric or textual
3. Epistemic

The **local anaphoric use** is the one that pertains to our work, so we will restrict ourselves to discussion of this. The **global anaphoric** use concerns a contrastive now/then distinction in discourse which may lie outside the confines of individual clauses (what Schiffrin calls a global contrast). Schiffrin shows how all three uses of 'then' — local anaphoric, textual and epistemic — can be viewed in terms of proximal/distal oppositions of various kinds.

Within the local anaphoric use she identifies two functions:

1. Shifting reference time

from the prior text. Schiffrin shows that, in general, sentence-initial 'then' indicates a shift in reference time and sentence-final 'then' a continuation of the reference time established in the previous discourse. This use of reference times is similar to that of Spejewski and Carlson, except that the latter argue that a new reference time should be introduced for every eventuality irrespective of its aspectual category. Schiffrin notes that because of the effect on reference times, sentence-initial 'then' is normally associated with a following event, and sentence-final 'then' usually modifies a state. She presents a wide range of data, taken from personal interviews, to demonstrate this association. She also considers the "exceptions", where sentence-final 'then' modifies not a state but an event, and sentence-initial 'then' precedes a state. In these cases, she observes, 'then' can override the normal aspectual meanings of clause/clause sequences. For example, if an event is followed by a state (in the absence of 'then') we normally interpret this as the state temporally overlapping the event. However, if the state is preceded by sentence-initial 'then', this effect is overridden and we read the state as non-overlapping. Schiffrin explains this in terms of sentence-inital 'then' causing us to focus on the event that marks the beginning of the state. Similarly, if sentence-final 'then' is preceded by an event, this can cause the "opening" up of a state following the event. Schiffrin's explanation is rather informal at this point and would perhaps benefit from the inclusion of an account of event structure — for example that of (Moens 1987), which would enable her to speak of an event and its **consequent state**.

Schiffrin does not consider any examples of sentence-final 'then' with elaborations, and it is not clear how her account would deal with these. Nor does she consider progressives or explicit temporal reference.

2.9 Summary and Conclusion

We have identified a two-way distinction in the use of 'then':

1. As a temporal anaphor referring back to an explicit temporal referent.

2. As a means of expressing discourse relations such as PART-OF between eventualities.

In order to express this distinction in DRT we have suggested using:

1. Temporal referents, which may only be introduced by explicit reference to "times". Such explicit reference to times is provided (at least) by temporal frame adverbials and 'at'-adverbials, but not by 'for'-adverbials, for example.

2. Event or state referents, which are introduced when an eventuality is described. Although it may be possible for the hearer to infer information about the times corresponding to these eventualities, the crucial point is that such inferred times are not introduced into the universe of discourse of the DRS.

Making such a distinction allows us to account for the data involving 'then', 'at the time' and 'at the same time'. The distinction brings out the need for semantic representations of natural language discourse to reflect not only truth conditions in the world, but the way that the information contained in the discourse is structured.

We are not claiming that the formal account presented below is the only way that the necessary distinction can be made. In Chapter 3 we will present an alternative way of formalizing the distinction, cast in the framework of DRT and situation theory developed in (Barwise and Cooper 1993).

2.10 Fragment

2.10.1 Introduction

We present here a more formal version of our analysis of 'then'. We take as our starting point the DRT fragment developed in Chapter 5 of (Kamp and Reyle 1993). Kamp and Reyle's fragment covers a range of simple English sentences with past, present and future tense, simple and progressive aspect and temporal adverbials — but there is no treatment of 'then'. They present phrase structure rules, rules for DRS construction, and a model theory for the fragment. We have added extra phrase structure rules so as to include a syntactic analysis of sentence-initial and sentence-final 'then'. We have also added further construction rules which reflect our semantic analysis of 'then' and build the correct DRSs for the sentences of our fragment. In addition, we have modified several of Kamp and Reyle's construction rules for our purposes. No modifications to Kamp and Reyle's model theory were required.

In the interests of simplicity, we have reduced the size of the fragment by excluding some constructions that are not relevant to the analysis of 'then'. These include the perfect, negation, tenses other than the past, definite and indefinite articles, and pronouns. We do not foresee any problems with putting these constructions back into the fragment.

After presenting our fragment, we will illustrate how our rules generate the appropriate DRSs for the key examples discussed earlier.

2.10.2 Phrase Structure Rules

The following rules are adapted from Kamp and Reyle (1993). We have reduced the size of the fragment by removing some constructions and the corresponding rules, and we have added new rules to deal with 'then'. Accordingly, some features are now redundant and have been removed, and several new features have been added. All features are explained below.

We replace Kamp and Reyle's feature *TENSE* with the feature *Past* which can take values $\{+, -\}$ and indicates past tense or otherwise (all sentences in our fragment are past tense).

The feature *Stat* indicates stative/non-stative and can take values $\{+, -\}$.

The feature Fin can take values $\{+, -, prog\}$, and indicates finite/infinite and progressive.

The feature $Trans$ indicates transitivity and can take the values '+' (transitive) and '−' (intransitive).

The feature *Ocat* can take value *oref* (indicating reference to an object) or *tref* (indicating reference to a time).

The feature *Unit* indicates the unit of temporal measurement, and is intended to coordinate pronouns like 'July' with prepositions like 'in'. *Unit* can only take the value *month* in this fragment.

We introduce a new feature *Init*, which can take the values $\{+, -\}$, to distinguish sentence-initial and sentence-final 'then'.

We have added two new features: *Ana* and *Etr*, at AdvP level. *Ana* takes the value '+' if the AdvP is anaphoric (as is the case with 'then') and '−' if it is non-anaphoric, as is the case with the temporal frame adverbials in the fragment. *Etr* takes the value '+' if the AdvP makes explicit reference to a time (as is the case with the frame adverbials) and '−' if it does not do so, as is the case with 'then'.[17]

(PS.1)

$$\mathrm{S}\begin{bmatrix} Stat & = & \alpha \\ Past & = & \beta \end{bmatrix} \quad \rightarrow \quad \mathrm{NP} \quad \mathrm{VP'}\begin{bmatrix} Stat & = & \alpha \\ Past & = & \beta \end{bmatrix}$$

(PS.2)

$$\mathrm{S'}\begin{bmatrix} Stat & = & \alpha \\ Past & = & \beta \end{bmatrix} \quad \rightarrow \quad \mathrm{S}\begin{bmatrix} Stat & = & \alpha \\ Past & = & \beta \end{bmatrix}$$

(PS.3) $$\mathrm{S'}\begin{bmatrix} Stat & = & \alpha \\ Past & = & \beta \end{bmatrix} \quad \rightarrow \quad \mathrm{AdvP}\begin{bmatrix} Init & = & + \\ Stat & = & \alpha \\ Past & = & \beta \end{bmatrix} \quad \mathrm{S}\begin{bmatrix} Stat & = & \alpha \\ Past & = & \beta \end{bmatrix}$$

[17]In fact for the purposes of this fragment *Ana* and *Etr* are complementary and could be condensed into one feature. However for a larger fragment this may not be the case. For example, 'for'-adverbials would need to have the feature values [$Etr = -$] and [$Ana = -$].

(PS.4)

$$\text{S}'\begin{bmatrix} \mathit{Stat} = \alpha \\ \mathit{Past} = \beta \end{bmatrix} \rightarrow \text{S}\begin{bmatrix} \mathit{Stat} = \alpha \\ \mathit{Past} = \beta \end{bmatrix} \text{AdvP}\begin{bmatrix} \mathit{Init} = - \\ \mathit{Stat} = \alpha \\ \mathit{Past} = \beta \end{bmatrix}$$

(PS.5)

$$\text{VP}'\begin{bmatrix} \mathit{Fin} = + \\ \mathit{Stat} = \alpha \\ \mathit{Past} = \beta \end{bmatrix} \rightarrow \text{VP}\begin{bmatrix} \mathit{Fin} = + \\ \mathit{Stat} = \alpha \\ \mathit{Past} = \beta \end{bmatrix}$$

(PS.6)

$$\text{VP}\begin{bmatrix} \mathit{Fin} = \alpha \\ \mathit{Stat} = \beta \\ \mathit{Past} = \gamma \end{bmatrix} \rightarrow \text{V}\begin{bmatrix} \mathit{Fin} = \alpha \\ \mathit{Stat} = \beta \\ \mathit{Past} = \gamma \\ \mathit{Trans} = + \end{bmatrix} \text{NP}$$

(PS.7)

$$\text{VP}\begin{bmatrix} \mathit{Fin} = \alpha \\ \mathit{Stat} = \beta \\ \mathit{Past} = \gamma \end{bmatrix} \rightarrow \text{V}\begin{bmatrix} \mathit{Fin} = \alpha \\ \mathit{Stat} = \beta \\ \mathit{Past} = \gamma \\ \mathit{Trans} = - \end{bmatrix}$$

(PS.8)

$$\text{VP}\begin{bmatrix} \mathit{Stat} = + \\ \mathit{Past} = \alpha \end{bmatrix} \rightarrow \text{BE}\begin{bmatrix} \mathit{Past} = \alpha \end{bmatrix} \text{VP}\begin{bmatrix} \mathit{Fin} = \mathit{prog} \\ \mathit{Stat} = - \end{bmatrix}$$

(PS.9)

$$\text{NP}\begin{bmatrix} \mathit{Unit} = \alpha \\ \mathit{Ocat} = \mathit{tref} \end{bmatrix} \rightarrow \text{PN}\begin{bmatrix} \mathit{Unit} = \alpha \\ \mathit{Ocat} = \mathit{tref} \end{bmatrix}$$

(PS.10)

$$\text{NP}_{\begin{bmatrix} Ocat = oref \end{bmatrix}} \rightarrow \text{PN}_{\begin{bmatrix} Ocat = oref \end{bmatrix}}$$

(PS.11)

$$\text{AdvP}_{\begin{bmatrix} Init = \alpha \\ Etr = + \\ Ana = - \\ Stat = \beta \end{bmatrix}} \rightarrow \text{Prep}_{\begin{bmatrix} Unit = \gamma \end{bmatrix}} \text{NP}_{\begin{bmatrix} Unit = \gamma \\ Ocat = tref \end{bmatrix}}$$

2.10.3 Lexical Insertion Rules

(LI.1)

$$\text{PN}_{\begin{bmatrix} Ocat = oref \end{bmatrix}} \rightarrow \text{Daniel, Gareth, Ben Nevis, Snowdon}$$

(LI.2)

$$\text{PN}_{\begin{bmatrix} Ocat = tref \\ Unit = month \end{bmatrix}} \rightarrow \text{July}$$

(LI.3)

$$\text{Prep}_{\begin{bmatrix} Unit = month \end{bmatrix}} \rightarrow \text{in}$$

(LI.4)

$$\text{AdvP}_{\begin{bmatrix} Init = \alpha \\ Ana = + \\ Etr = - \end{bmatrix}} \rightarrow \text{then}$$

(LI.5)

$$\mathrm{BE}\begin{bmatrix} Fin = & + \\ Past = & + \end{bmatrix} \quad \rightarrow \quad \text{was}$$

(LI.6)

$$\mathrm{V}\begin{bmatrix} Trans = & + \\ Stat = & - \end{bmatrix} \quad \rightarrow \quad \text{climb}$$

(LI.7)

$$\mathrm{V}\begin{bmatrix} Trans = & - \\ Stat = & - \end{bmatrix} \quad \rightarrow \quad \text{run}$$

(LI.8)

$$\mathrm{V}\begin{bmatrix} Trans = & + \\ Stat = & + \end{bmatrix} \quad \rightarrow \quad \text{like}$$

(LI.9)

$$\mathrm{V}\begin{bmatrix} Fin = & + \\ Trans = & \alpha \\ Stat = & \beta \\ Past = & + \end{bmatrix} \quad \rightarrow \quad \text{Past(d)}, \qquad \text{where} \;\; \mathrm{d} \in \mathrm{V}\begin{bmatrix} Trans = & \alpha \\ Stat = & \beta \end{bmatrix}$$

(LI.10)

$$\mathrm{V}\begin{bmatrix} Fin = & + \\ Trans = & \alpha \\ Stat = & \beta \\ Past = & + \end{bmatrix} \quad \rightarrow \quad \text{Ger(d)}, \qquad \text{where} \;\; \mathrm{d} \in \mathrm{V}\begin{bmatrix} Trans = & alpha \\ Stat = & \beta \end{bmatrix}$$

Past(climb) = climbed

Past(like) = liked

Past(run) = ran

Ger(climb) = climbing

Ger(like) = liking

Ger(run) = running

2.10.4 Construction Rules

We give here the complete set of construction rules needed to generate DRSs for the sentences of our fragment. Some of the rules have been taken unchanged from (Kamp and Reyle 1993), and we indicate below the rule where this is the case. Most of the rules have been modified to incorporate our analysis, and some new rules have been added to deal with 'then'.

CR.PN, which deals with the processing of proper names, is taken unchanged from (Kamp and Reyle 1993). We have simplified it slightly by removing features which are not required in our fragment.

Note that:

Triggering configuration: $\gamma \in Con_k$

is used in our rules, as in Kamp and Reyle's, to express the requirement that the syntactic structure γ be among the conditions of the DRS K. If the configuration γ may either be a proper subtree of the condition or the condition as a whole, we write:

Triggering configuration: $\gamma \subseteq \overline{\gamma} \in Con_k$.

CR.PN

Triggering configuration: $\gamma \subseteq \overline{\gamma} \in Con_k$

```
      S
     / \
   NP   VP'
   |
   PN
   |
   α
```

or:

```
     VP
    /  \
   V    NP
        |
        PN
        |
        α
```

Introduce into the universe of the main DRS: new discourse referent u
Introduce into the condition set of the main DRS: new condition $\alpha(u)$
Substitute in $\overline{\gamma}$: u for

```
   NP
   |
   PN
   |
   α
```

We have modified K&R's S′ rule CR.$S'_{TA=<TENSE,STAT,NEG>}$
(where $TA = < TENSE, STAT, NEG >$ is a shorthand way of representing the tense/aspect features of S and indicates the values of the features $TENSE$, $STAT$ and NEG) to give three rules. The first is

CR.$S'_{\mathrm{TA}=<+,\beta>}$,

which applies to sentences with no temporal adverbial and indicates that $Past = +$ and $Stat = \beta$.

The second is:

$\mathrm{CR.S'}_{\mathrm{TA}=<+,\beta,-,+>}$

which applies to sentences with temporal adverbials where $Past = +$, $Stat = \beta$, $Ana = -$ and $Etr = +$.

The third is:

$\mathrm{CR.S'}_{\mathrm{TA}=<+,\beta,+,->}$

which applies to sentences with temporal adverbials where $Past = +$, $Stat = \beta$, $Ana = +$ and $Etr = -$.

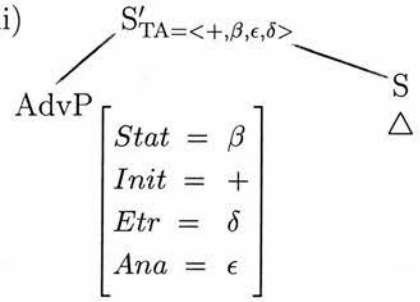
For reasons of simplicity, we have removed Kamp and Reyle's temporal perspective point and reference point, which are not required by our fragment. They concern temporal updating in discourse and embedded narrative, and could be restored to the rules if required. Our new rules make reference to the features *Ana*, *Etr*, and *Init* which we added to the fragment.

The triggering configurations for these three rules are:

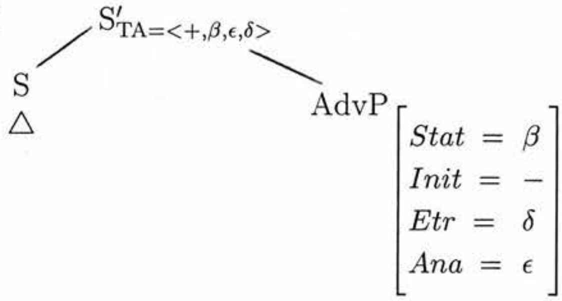
(i)

$$\begin{array}{l}\mathrm{S'}_{\mathrm{TA}=<+,\beta>}\\ \quad|\\ \mathrm{S}\\ \triangle\end{array}$$

(ii)



(iii)



As we said, the first rule for the case where no temporal adverbial is present in the sentence. Under these conditions, an event or state referent but no temporal referent is introduced.

$CR.S'_{TA=<+,\beta>}$
Triggering configuration: $\gamma \in Con_k$ for $\gamma =$ (i) above. **If** $Stat = +$, **then:** Introduce into U_K: new state discourse referent s Replace γ by $\underset{\triangle}{S(s)}$ **If** $Stat = -$, **then:** Introduce into U_K: new event discourse referent e Replace γ by $\underset{\triangle}{S(e)}$

The next rule applies when there is a temporal adverbial with the features $-Ana$ and $+Etr$ (i.e., a frame adverbial, in this fragment). Under these conditions, a temporal referent is introduced in addition to the event or state referent.

$\mathrm{CR.S'_{TA=<+,\beta,-,+>}}$
Triggering configuration: $\gamma \in Con_k$ for $\gamma =$ (ii) or (iii) above. **If** $Stat = +$, **then:** Add to $\mathrm{Con_k}$: AdvP(s,t) Introduce into $\mathrm{U_K}$: new state discourse referent s and new time discourse referent t Replace γ by $\underset{\triangle}{\mathrm{S}(s)}$ **If** $Stat = -$, **then:** Add to $\mathrm{Con_k}$: AdvP(e,t) Introduce into $\mathrm{U_K}$: new event discourse referent e and new time discourse referent t Replace γ by $\underset{\triangle}{\mathrm{S}(e)}$

The next rule applies when there is a temporal adverbial with the features $+Ana$ and $-Etr$ (i.e., 'then', in this fragment). Under these conditions, an event or state referent but no time referent is introduced. (The work of processing 'then' is done by the rules **CR.SF-then**, etc., which will be given shortly.)

$\mathrm{CR.S}'_{\mathrm{TA}=<+,\beta,+,->}$

Triggering configuration: $\gamma \in Con_k$
for $\gamma =$ (iii) above.

If $Stat = +$**, then:**
Add to $\mathrm{Con_k}$: AdvP(s)
Introduce into $\mathrm{U_K}$: new state discourse referent s

Replace γ by $\underset{\triangle}{\mathrm{S}(s)}$

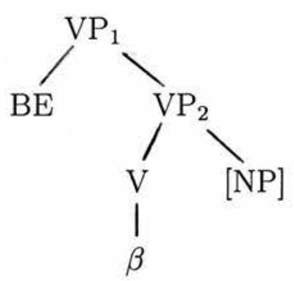
If $Stat = -$**, then:**
Add to $\mathrm{Con_k}$: AdvP(e)
Introduce into $\mathrm{U_K}$: new event discourse referent e

Replace γ by $\underset{\triangle}{\mathrm{S}(e)}$

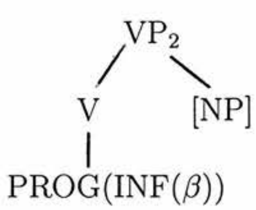
In order to deal with progressives, we use K&R's construction rule **CR.BE** exactly as it stands.

CR.BE

Triggering configuration: $\gamma \subseteq \overline{\gamma} \in Con_k$



Replace γ by:



Note: Square brackets around the NP indicate that it is optional — to enable the rule to deal with both transitive and intransitive cases.

We introduce a rule **CR.July** corresponding to K&R's rule **CR.Sunday**. Both 'Sunday' and 'July' are frame adverbials so the rules are similar. However, we have made some modifications.

Our rule for events introduces the condition (in the non-stative case):

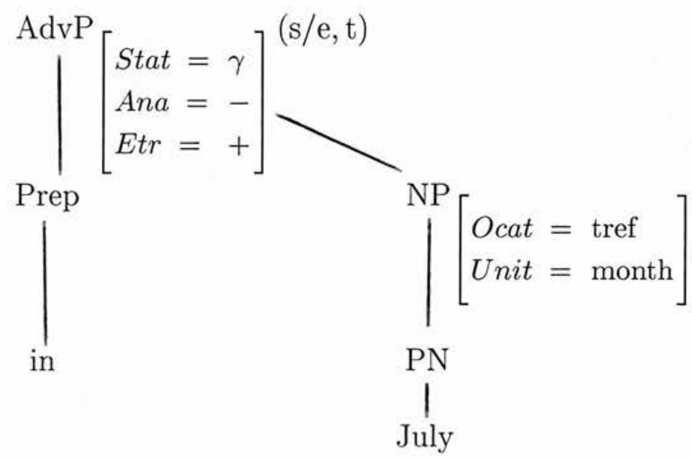
$e \sqsubseteq t$

which is to be interpreted, as explained earlier, as the event e occurring within time t. (The rule for statives introduces a slightly different condition, shown below.)

We have also removed information, as explained earlier, concerning the temporal perspective point.

CR.July

Triggering configuration: $\gamma \subseteq \overline{\gamma} \in Con_k$



Introduce into $\mathrm{Con_k}$: july(t)
If $Stat = +$, introduce into $\mathrm{Con_k}$: $s \circ t$
If $Stat = -$, introduce into $\mathrm{Con_k}$: $e \sqsubseteq t$

Note: s/e is to be interpreted as 's or e, whichever is appropriate'. The relation $\circ$ is to be interpreted as "temporally overlaps".

Finally, we give our construction rules for 'then'. The first of these, **CR.SI-then**, is for sentence-initial 'then'. It introduces a condition to the effect that the current eventuality cannot be PART-OF the previous eventuality (as argued in the text), and a condition which says that the previous eventuality temporally precedes the current one.

CR.SI-then

Triggering configuration: $\gamma \subseteq \overline{\gamma} \in Con_k$

$$\begin{array}{c} \text{AdvP} \begin{bmatrix} Init & = & + \\ Etr & = & - \\ Ana & = & + \\ Stat & = & \delta \end{bmatrix} (\mathrm{e_i}/\mathrm{s_i}) \\ | \\ \text{then} \end{array}$$

Replace γ by new conditions:
$\mathrm{s_{i-1}}/\mathrm{e_{i-1}} \prec \mathrm{s_i}/\mathrm{e_i}$,
$\neg(\mathrm{s_i}/\mathrm{e_i}$ PART-OF $\mathrm{s_{i-1}}/\mathrm{e_{i-1}})$

Note: $\prec$ is to be interpreted as "temporally precedes".

The subscripts of $\mathrm{e_{i-1}}$ and $\mathrm{s_{i-1}}$ refer to the event/state discourse referent introduced by the previous sentence. We assume that the construction algorithm assigns numerically increasing subscripts to successive eventuality and time referents introduced by the discourse.

CR.SF-then-ETR is our new rule corresponding to the ETR reading of sentence-final 'then'. It chooses the most recently introduced temporal referent and introduces a condition relating the event/state in the current sentence to this.

CR.SF-then-ETR

Triggering configuration: $\gamma \subseteq \overline{\gamma} \in Con_k$

$$\begin{array}{l} \text{AdvP} \begin{bmatrix} Init & = & - \\ Etr & = & - \\ Ana & = & + \\ Stat & = & \delta \end{bmatrix}^{(e/s)} \\ \quad | \\ \text{then} \end{array}$$

Choose a suitable antecedent t_j, such that j is maximal.
If $[Stat = +]$: Replace γ by new conditions: $t_j \circ s$
If $[Stat = -]$: Replace γ by new conditions: $e \sqsubseteq t_j$

By 'choose a suitable antecedent t_j, such that j is maximal' we mean that the antecedent with the maximum value of j should be chosen. Recall that j is the index for the utterance, and is incremented by one for each new utterance. Thus the idea is that the rule selects the most recently introduced temporal referent.

CR.SF-then-PART is our rule corresponding to the PART-OF reading of sentence-final 'then'. We argued earlier that this reading of 'then' requires that the current eventuality can be seen as PART-OF the previous eventuality. This is possible if there is either a background or an elaboration relation. Deciding whether an elaboration relation is possible requires world knowledge, and we have not attempted to build this into the fragment (though there is no reason why this could not be done). So in our fragment we ignore the elaboration relation, and our rule only allows the PART-OF reading of SF-'then' if a background relation is possible. As it appears that a background relation is always possible if the current eventuality is a state, we impose the condition here that the current eventuality is stative. Thus, our rule is correct but not complete.

CR.SF-then-PART

Triggering configuration: $\gamma \subseteq \overline{\gamma} \in Con_k$

$$\begin{array}{l} \text{AdvP} \left[\begin{array}{lcl} Init & = & - \\ Etr & = & - \\ Ana & = & + \\ Stat & = & + \end{array} \right] (\mathrm{s_i}) \\ \quad | \\ \text{then} \end{array}$$

If previous sentence was stative, replace γ by new condition:
$\mathrm{s_i}$ PART-OF $\mathrm{s_{i-1}}$

If previous sentence was non-stative, replace γ by new condition:
$\mathrm{s_i}$ PART-OF $\mathrm{e_{i-1}}$

Note that this rule requires us to keep track of the *Stat* value for the previous sentence. We do not consider here the precise means for doing this, but assume that some relatively straightforward way of maintaining this information could be found.

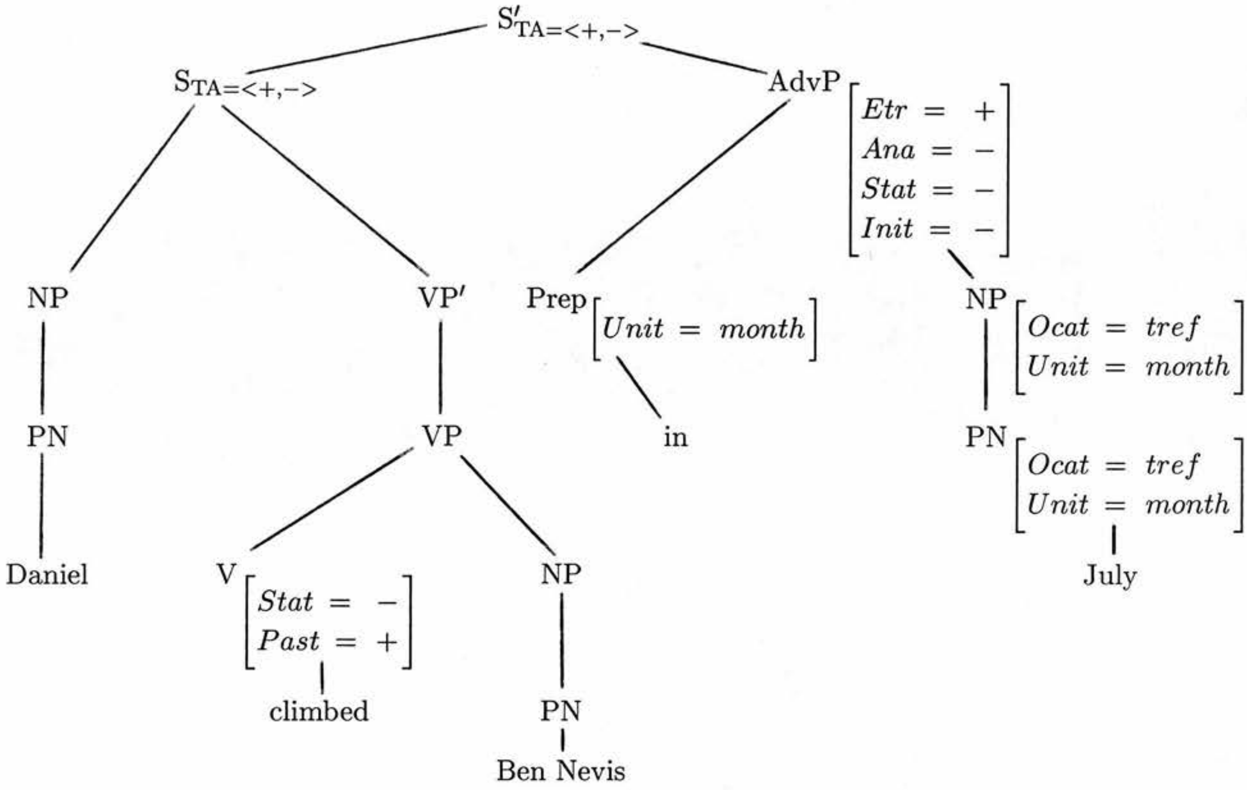
2.11 Examples of DRS Construction

We show here how the rules given above generate the required DRSs for the key examples in the text.

We begin with sequence (2.1a,2.1b), reproduced here as (2.35a,2.35b).

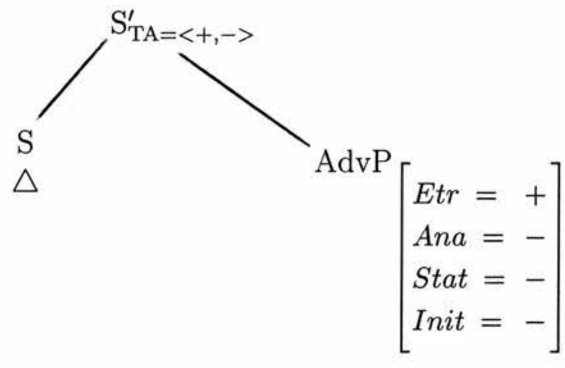
(2.35) a. Daniel climbed Ben Nevis in July
b. Gareth climbed Snowdon then

Syntactic parsing of (2.35a) according to the PS rules given above yields the following parse tree:



DRS construction proceeds as follows.

The structure:



causes rule $\mathbf{CR}.\mathrm{S}'_{\mathrm{TA}=<+,\beta,-,+>}$ to be invoked. This causes an event discourse referent e_1 to be introduced into the DRS. It also introduces a temporal discourse referent t_1. The condition:

$\mathrm{AdvP}(\mathrm{e}_1, \mathrm{t}_1)$

is also introduced.

The AdvP is processed as follows.

CR.July introduces the conditions:

$e_1 \sqsubseteq t_1$

july(t_1)

So the DRS obtained so far is (simplified slightly):

e_1 t_1
$e_1 \sqsubseteq t_1$ july(t_1)

The rule **CR.PN**, which introduces nominal discourse referents, will also be invoked by the syntactic structure. This will cause discourse referents to be introduced corresponding to the proper names 'Daniel' and 'Ben Nevis'.

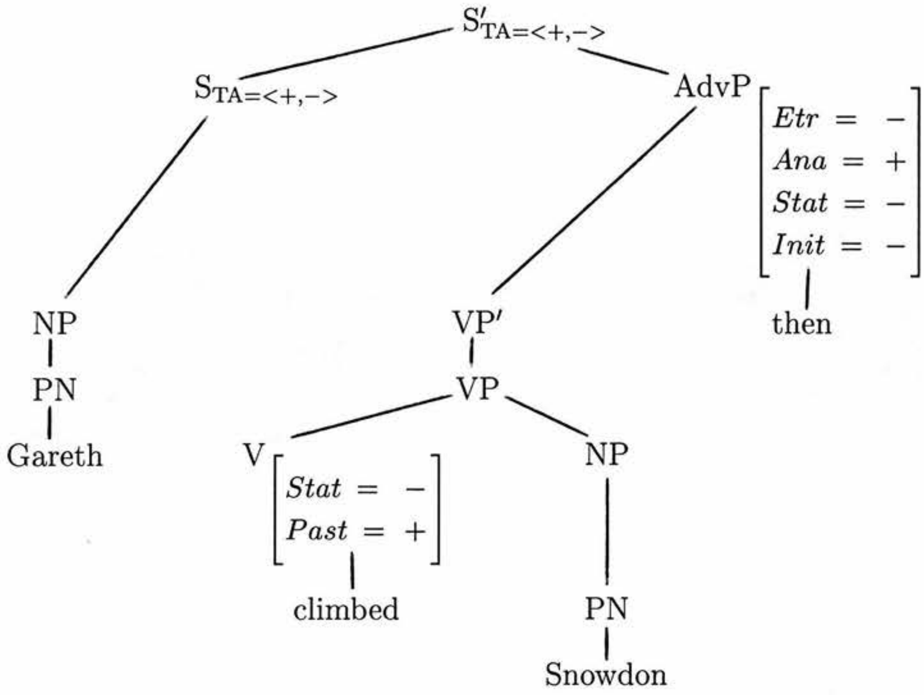
After processing the whole parse tree the completed DRS will be as follows:

e_1 t_1 u v
$e_1 \sqsubseteq t_1$ july(t_1) Daniel(u) Ben Nevis(v) e_1: $\boxed{\text{u climb v}}$

Now let us consider the second sentence of the sequence, (2.35b):

(2.35) b. Gareth climbed Snowdon then

The syntactic parse (showing relevant features) for (2.36b) is:



Rule $\mathbf{CR}.\mathrm{S}'_{\mathrm{TA}=<+,\beta,+,->}$ is invoked, causing an event discourse referent e_2 to be introduced into the universe of discourse. However, in this case no temporal discourse referent is introduced. The condition:

$\mathrm{AdvP(e_2)}$

is added.

Nominal discourse referents w and x, corresponding to 'Gareth' and 'Snowdon' respectively are also added. At this point our DRS would be (simplifying slightly to remove details of syntactic structure):

$$
\begin{array}{|l|}
\hline
\quad e_1\ t_1\ u\ v\ e_2\ w\ x \\
\hline
\\
e_1 \sqsubseteq t_1 \\
\text{july}(t_1) \\
\text{Daniel}(u) \\
\text{Ben Nevis}(v) \\
e_1\text{: } \boxed{\text{u climb v}} \\
\text{Gareth}(w) \\
\text{Snowdon}(x) \\
\begin{array}{l} \text{AdvP} \\ \quad | \\ \text{then} \end{array} \begin{bmatrix} \mathit{Init} = - \end{bmatrix} (e_2) \\
\\
\hline
\end{array}
$$

However, we still have not processed 'then'. Recall that we have two construction rules to deal with sentence-final 'then'. **CR.SF-then-ETR** deals with the ETR reading and **CR.SF-then-PART** deals with the PART-OF reading.

CR.SF-then-ETR can only be invoked if a time discourse referent is available. As such a referent is available here, and the requisite features are present on the AdvP, the rule is invoked, and the condition

$e_2 \sqsubseteq t_1$

is added. (In this case, only one time discourse referent is present. If, as might be the case in a longer discourse, there were more than one such referent present, the most recently introduced one would be chosen. This is doubtless an oversimplification, and a theory of discourse structure would be required in order to do it properly.)

Thus our completed DRS for (2.36a,2.36b) would be as follows:

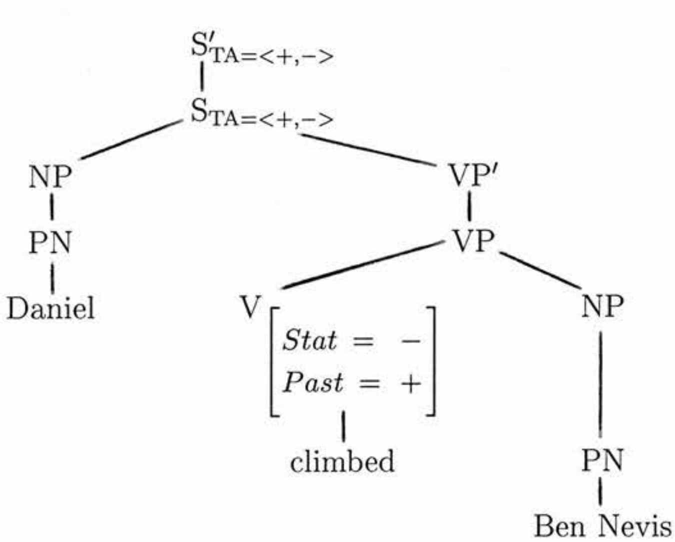
e_1 t_1 u v e_2 w x
$e_1 \sqsubseteq t_1$ july(t_1) Daniel(u) Ben Nevis(v) e_1: $\boxed{\text{u climb v}}$ Gareth(w) Snowdon(x) e_2: $\boxed{\text{w climb x}}$ $e_2 \sqsubseteq t_1$

Note that rule **CR.SF-then-PART** is not invoked here. This is because this rule requires that the sentence containing 'then' be stative. Thus in the case of (2.36a,2.36b) only the ETR reading is obtained, which is what we require.

Now let us consider the sequence (2.36a,2.36b).

(2.36) a. Daniel climbed Ben Nevis
b. Gareth climbed Snowdon then

The parse tree for (2.36a) is:



Rule **CR.**$S'_{TA=<+,\beta>}$ is invoked, which causes an event discourse referent e_1 but no temporal discourse referent to be introduced into the universe of discourse.

From this point, DRS construction proceeds in a similar way as for (2.36a), and the final DRS for (2.37a) is :

$$\begin{array}{|l|}\hline e_1\ u\ v \\ \hline \text{Daniel}(u) \\ \text{Ben Nevis}(v) \\ e_1\text{: } \boxed{u \text{ climb } v} \\ \hline \end{array}$$

Now consider (2.37b). This is identical to (2.36b), so the same construction rules will be invoked apart from those involving 'then'. Thus we obtain the intermediate DRS:

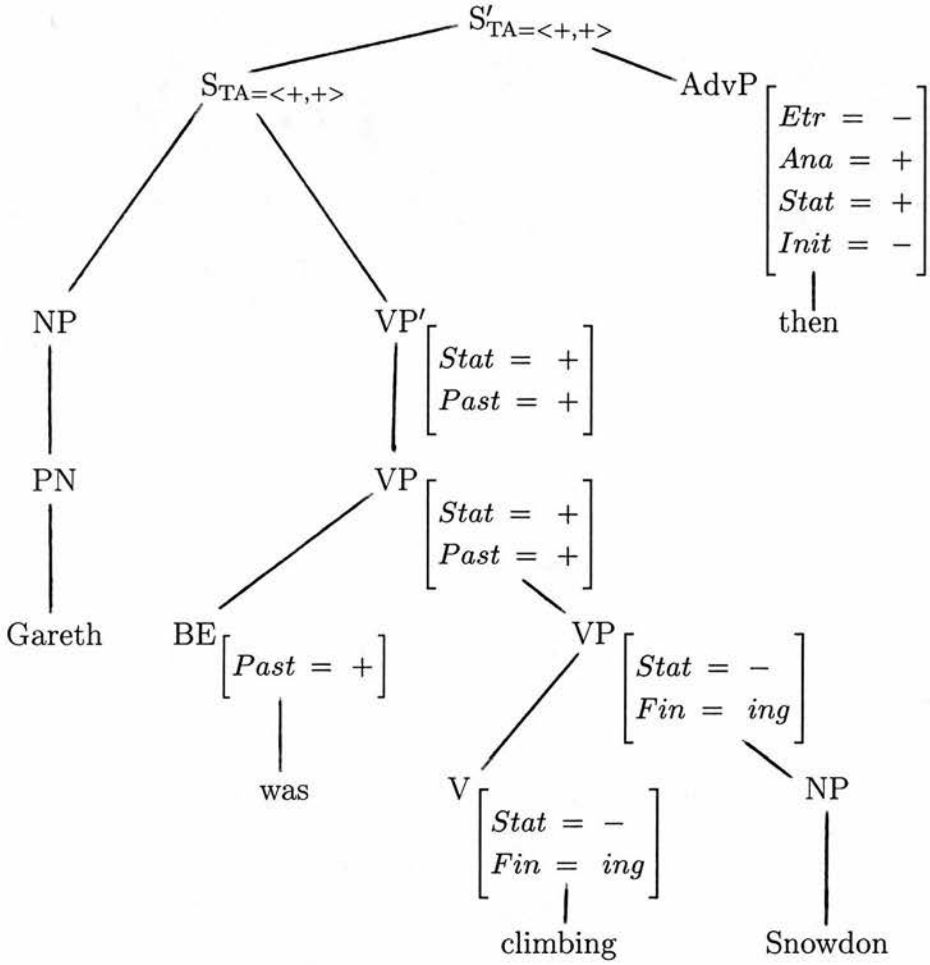
$$\begin{array}{|l|}\hline e_1\ u\ v\ e_2\ w\ x \\ \hline \text{Daniel}(u) \\ \text{Ben Nevis}(v) \\ e_1\text{: } \boxed{u \text{ climb } v} \\ \text{Gareth}(w) \\ \text{Snowdon}(x) \\ \text{AdvP} \left[\begin{array}{lcl} Init & = & - \\ Etr & = & - \\ Ana & = & + \\ Stat & = & - \end{array}\right] (e_2) \\ \text{then} \\ \hline \end{array}$$

At this point, a rule is required to reduce the AdvP. However, it will be seen from looking at the two rules for SF-'then', that neither of them can be invoked. **CR.SF-then-ETR** requires that there be a temporal referent in the universe of discourse, and no such referent is present. And **CR.SF-then-PART** requires that the sentence containing 'then' be stative, which is not the case for (2.37b). Thus no further rules can be invoked at this point and there is no analysis for (2.37a,2.37b), which is precisely what we require.

Now suppose (2.37b) were replaced by (2.37c):

(2.36) c. Gareth was climbing Snowdon then

(2.37c) receives the parse:



The difference here is that (2.37c) is stative. This means that the conditions for invocation of **CR.SF-then-PART** are met, so this rule is triggered and the condition:

s_2 PART-OF e_1

is added to the DRS.

The final DRS for (2.37a,2.37c) is:

$$
\begin{array}{|l|}
\hline
\quad e_1 \; u \; v \; s_2 \; w \; x \\
\hline
\\
\text{Daniel}(u) \\
\text{Ben Nevis}(v) \\
e_1 \text{: } \boxed{u \text{ climb } v} \\
\text{Gareth}(w) \\
\text{Snowdon}(x) \\
s_2 \text{: } \boxed{w \text{ PROG(climb) } x} \\
s_2 \text{ PART-OF } e_1 \\
\\
\hline
\end{array}
$$

Finally, consider the sequence (2.36a,2.36c):

(2.35) a. Daniel climbed Ben Nevis in July

c. Gareth was climbing Snowdon then

We have already given the DRS for (2.36a), and (2.36c) is identical to (2.37c). Combining the two DRSs, at the point where we are looking for a rule for 'then', we will have the DRS:

$$
\begin{array}{|l|}
\hline
\quad e_1 \; t_1 \; u \; v \; s_2 \; w \; x \\
\hline
\\
e_1 \sqsubseteq t_1 \\
\text{july}(t_1) \\
\text{Daniel}(u) \\
\text{Ben Nevis}(v) \\
e_1 \text{: } \boxed{u \text{ climb } v} \\
\text{Gareth}(w) \\
\text{Snowdon}(x) \\
\text{AdvP} \begin{bmatrix} \mathit{Init} = - \\ \mathit{Etr} = - \\ \mathit{Ana} = + \\ \mathit{Stat} = + \end{bmatrix} (s_2) \\
\text{then} \\
\\
\hline
\end{array}
$$

We can see from this that both **CR.SF-then-ETR** and **CR.SF-then-PART** can be invoked at this point. Thus, we can produce two alternative final DRSs, one by adding the condition:

$t_1 \circ s_2$ (which corresponds to the ETR reading)

and one by adding the condition:

s_2 PART-OF e_1 (which corresponds to the PART-OF reading).

Thus we have shown how DRSs are constructed for our key examples in accordance with our analysis.

2.12 A Potential Problem with the DRT Account

Our analysis of 'then' motivated the need to distinguish between cases where an explicit temporal referent (ETR) is present and cases where a time is merely inferred from the mention of an eventuality. We showed how this can be done in DRT by allowing a temporal discourse referent only to be introduced into the DRS when an ETR is present. This worked well for the fragment given and gave us the required readings for sentence-final 'then'. At first glance it does not appear that there would be any significant problem in extending this treatment to larger fragments. One problem that suggests itself is that in a larger fragment we might well want to use **reference points** and **temporal perspective points** in a way similar to that of Kamp and Reyle (1993) in order to give a fuller account of temporal relations in discourse. If reference points and the like are taken to be "times" (as is traditional in accounts based on Reichenbach 1947), there will be difficulties, as of course reference times are not always explicitly realised in the discourse. However, if we follow Kamp and Reyle in regarding reference points and temporal perspective points as corresponding to **events**, then we will have no trouble.

However, on further consideration a deeper problem suggests itself. It is perhaps assuming too much that we will always be able to limit temporal discourse referents to being introduced by ETRs. There may well be cases where it is necessary or at least extremely convenient to allow a temporal discourse referent to be introduced into the DRS even when no corresponding ETR is present in the discourse. Certainly, it appears to be an inherent disadvantage to limit ourselves in this way, even though we have not yet encountered any cases where this becomes necessary. In fact, to move ahead of ourselves a little, we will find in our analysis of 'at the time' and 'at the same time' in Chapter 4 that we need to talk about time roles associated with eventualities, where these time roles are considered to be present in the discourse context and must therefore appear in the DRS. But of course we will not be able to do this if we limit temporal discourse referents to being introduced by ETRs. What we need is to find a way to distinguish between times that we call "time roles" (which are inferred from the description of an eventuality) and times that we call "time entities" (which are introduced by ETRs). Conventional DRT does not give us any obvious way to do this. We would need to introduce information about the utterance into the DRS, and although we do not claim that doing this would be impossible (e.g., perhaps we could modify the DRS to retain the required syntactic information, or perhaps we could introduce some kind of partitioning of discourse referents) it would be potentially complicated and would take us away from standard DRT.

We need our semantic representations of discourse to specify whether a particular temporal discourse referent is a "time role" or a "time entity" — or, in other words, whether it was introduced by an ETR in the utterance or by inference from an eventuality. A way of specifying such information about an utterance is provided by combining ideas from situation theory and DRT along the lines of Cooper's situation-theoretic DRT (STDRT) (Cooper 1993b, 1993c). In Chapter 3 we will develop a fragment in our extended version of STG (known as discourse-STG or DSTG), which is inspired in part by the intuitions underlying STDRT. We will show how DSTG can be used to develop an alternative formulation of the required distinction and give the correct readings for 'then' without the problems described above.

Chapter 3

A Situation Theory/DRT Fragment for 'then'

Note: An earlier version of some of the material described in this chapter and in Chapter 5 has been reported in (Glasbey 1993c).

3.1 Introduction

In Chapter 2 we presented a DRT fragment which embodied our theoretical analysis of sentence-final 'then'. The fragment consisted of an extension to that given in (Kamp and Reyle 1993, Ch.5). We made the necessary distinction between explicit and implied "times" by allowing temporal discourse referents to be introduced into the DRS only in cases where a "time" was referred to by an **explicit temporal referent** (ETR). Making this distinction allowed us to generate the required readings for sentence-final 'then'.

At the end of Chapter 2 we pointed out a potential problem with the way that our DRT fragment for 'then' made the distinction between explicitly mentioned times and inferred times. We suggested that there might be cases where it is very convenient or even essential to allow temporal discourse referents/markers to be introduced even where there is no explicit temporal referent. In the present chapter we will describe an alternative way of making the requisite distinction.

We will work within a framework that embodies ideas from situation theory (ST) and DRT, using insights from (Cooper 1993b, 1993c) as to how these theories can be brought together. Our notation will be the Extended Kamp Notation (EKN) developed in (Barwise and Cooper 1993). We will develop a fragment which is similar in scope to the DRT fragment described in Chapter 2, but which uses a different means of obtaining the correct readings for sentence-final 'then'.

Although the work described here is related to and partly inspired by the situation theoretic discourse representation theory (STDRT) described in (Cooper 1993b, 1993c), the grammar we develop is different in some significant respects from the one presented by Cooper. For this reason, in order to avoid confusion we will refer to our framework as Discourse Situation Theoretic Grammar (DSTG). The name reflects the fact that our grammar was derived from the situation theoretic grammar (STG) presented in (Cooper 1991), by extending STG to deal with temporal expressions and the processing of discourse.

In our new fragment, we will make use of the fact that situation theory allows us to represent information about the utterance in a way that conventional DRT does not. Rather than restricting the introduction of temporal discourse referents to cases where an explicit temporal referent (ETR) is present, we will allow temporal discourse referents to be introduced even when there is no ETR. We will mark the difference between "explicit" and "inferred" temporal referents by indicating in the representation whether or not a referent was introduced by an ETR. This will enable us to obtain the correct readings for 'then' in a way which we believe will lend itself better to extension to larger fragments. For example, we will demonstrate in Chapter 4 when we look at 'at the time' and 'at the same time' that it is very useful to allow temporal discourse referents to be introduced even where no time is explicitly mentioned.

The incorporation of information about the utterance is very natural in a framework which treats utterances as situations. Of course, it may well be possible to extend DRT to include utterance information as well, but it would not be so easy to "background" the utterance information in the way that situation theory allows. Also, the resulting version of DRT would be significantly different from the standard version.

There are other reasons why using a combined situation theory / DRT framework seems advantageous. One is that situation theory gives us a natural and precisely defined semantics for the notion of PART-OF that we used in our analysis of 'then'.

A second advantage is that situation theory gives us a natural semantics for expressions in DRT like:

$e : \boxed{\text{climb(x,y)}}$

where climb(x,y) is a condition. In situation theory, e is a situation, and we can then say:

$e \models \text{climb}(\text{x}, \text{y})$

where $\text{climb}(\text{x}, \text{y})$ is an infon. We will discuss this further below.

Thirdly, using situations to model events will allow us to express notions of event structure which we will need when we look at aspectual classes and aspectual composition in Chapter 5.

The syntax of the fragment given here is based roughly on the syntactic rules for the DRT fragment presented in Chapter 2. The difference is that in the DRT fragment, based on (Kamp and Reyle 1993), a full syntactic analysis is carried out first, followed by the application of construction rules to the syntax tree. By contrast, in this fragment the syntactic and semantic analyses are carried out in tandem. This is done by having the grammar rules make reference to semantic as well as syntactic features. We base our rules on those of Cooper's STG as described in (Cooper 1988a, Cooper 1991), which we will briefly describe in Section 3.5.1 below. We have extended STG to deal with (1) tense and aspect, and (2) discourse. We will discuss in detail these modifications and the theoretical motivation for the way we have chosen to represent temporal information in DSTG.

Before presenting the DSTG fragment we will give a brief introduction to some of the key ideas and terminology of situation theory. Following this we will introduce Barwise and Cooper's Extended Kamp Notation (EKN) and some relevant ideas from Cooper's STDRT.

3.2 Situation Semantics and Situation Theory

Situation semantics was originally proposed as a theory of natural language semantics by Jon Barwise and John Perry in (Barwise and Perry 1983).[1] Since that time, alongside the development of situation semantics, much work has been done on the mathematical theory of information underlying situation semantics. The underlying theory has become known as situation theory.

The basic (semantic) objects of situation theory include **situations**,with **infons**, **relations** and **individuals**. A situation is characterised by the set of infons it **supports**. An infon has internal structure, as shown by the specimen infon below:

$\langle\langle \mathrm{eat}, \mathrm{e}, \mathrm{d}; 1 \rangle\rangle$

This infon can be thought to correspond to the sentence "Emily ate dinner".[2] The relation is 'eat', 'e' is a relevant individual named 'Emily', 'd' is an object referred to as 'dinner', and '1' is the polarity. The polarity of an infon may be '1' or '0'. Zero polarity would correspond to the equivalent "negative" sentence — i.e. 'Emily did not eat dinner' in this case. In this infon, the individuals 'e' and 'd' fill the **argument roles** of the relation 'eat'. The number of argument roles depends on the **arity** of the relation. Whether a particular relation has a fixed number of argument roles, or whether the number can vary, is a question not yet determined by the theory. Cooper (1991) introduces the notion of a **minimal appropriateness condition** which is associated with each argument role of a relation. This is a condition (not necessarily a sufficient one) which must be fulfilled in order for an object to be appropriate to that role (e.g. the condition 'human' or 'animate').

Note that the above infon does not contain any argument roles corresponding to time or place. Various suggestions have been made as to how spatial and temporal

[1]Many of the basic intuitions underlying the original version of situation semantics discussed in (Barwise and Perry 1983) remain unchanged, but the formalism and some key notions have changed considerably. The brief description that follows is based on recent versions of situation semantics and situation theory, such as (Barwise 1989) and (Barwise and Cooper 1993).

[2]We ignore information regarding tense and temporal reference here. We chose to put the above sentence in the past tense because the English present tense with simple aspect for non-stative verbs conveys a habitual sense, and we wish to avoid this complication here. We will discuss matters of tense and aspect later.

information should be incorporated in infons (see, for example Cooper 1985, Crow 1990, Macken 1990, Glasbey 1990, Devlin 1991). In Section 3.5.2 we will discuss this issue in more depth.

The argument roles of a relation may also be filled by other situation-theoretic objects, e.g. infons and situations.

A situation is said to **support** a collection of infons. Thus the following expression:

$s \models \langle\langle \mathrm{eat}, \mathrm{e}, \mathrm{d}; 1 \rangle\rangle$

means that a situation s supports the infon shown. We may also say that s is classified by the infon as being of the **type** corresponding to that infon.

Situations are individuated by the infons they support.

The argument roles of relations may also be filled by parameters, which are another kind of situation theoretic object. Parameters are similar to variables in conventional logics, except that parameters are semantic objects of the theory rather than varying over such objects. An infon which has one or more of its argument roles filled by a parameter is known as a parametric infon. For example:

$\langle\langle \mathrm{eat}, \mathrm{X}, \mathrm{Y}; 1 \rangle\rangle$

Until fairly recently the notion of a **restricted parameter** was in common use (see, for example, Gawron and Peters 1990).[3] Recently, however, an alternative has been developed (see Barwise and Cooper 1993) where it is objects such as infons and propositions (see below) that have restrictions associated with them. We will discuss this in more detail in the following section. We will also discuss there the notion of **abstraction** over parameters.

We mentioned above that situation theory also gives us a precise semantics for the informal notion of PART-OF which we used in Chapter 2. In situation theory, $\trianglelefteq$ (pronounced 'PART-OF') is a relation between situations. Barwise (1989) defines $\trianglelefteq$ as follows:

Definition:

[3] A restricted parameter is formed by taking a parameter X and a parametric proposition p(X) and combining them to give a new "restricted parameter" which ranges over objects y for which the proposition p(y) is true. See (Barwise and Cooper 1993) for further explanation.

> A situation S_2 is PART-OF ($\trianglelefteq$) a situation S_1 iff all the infons supported by S_2 are also supported by S_1.

For the purpose of our analysis, we take eventualities to be situations. This allows us to express PART-OF relations between eventualities.

To take an example of the PART-OF ($\trianglelefteq$) relation between situations; suppose that:

$S_2 \models \langle\langle \mathrm{climb}, \mathrm{d}, \mathrm{bn}; 1 \rangle\rangle$

and:

$S_2 \trianglelefteq S_1$

Then we can conclude that:

$S_1 \models \langle\langle \mathrm{climb}, \mathrm{d}, \mathrm{bn}; 1 \rangle\rangle$

3.3 Extended Kamp Notation

Barwise and Cooper (1993) present a graphical notation for situation theory known as Extended Kamp Notation (EKN).[4] This is based upon the box notation developed by Kamp (1981) for the discourse representation structures (DRSs) of DRT. One important difference between EKN and DRT is that in the former the boxes directly represent semantic objects such as infons, propositions and types, whereas DRSs in DRT are expressions of a language which require interpretation in a model. Nevertheless, EKN boxes look rather like DRSs and share their representational perspicuity.

Boxes are used in EKN to group together one or more items of the same sort in order to express conjunction of those items. The resulting conjunctive item will be of the same sort as the separate conjuncts. For example, the following represents the conjunction of the infons σ and τ.

[4] The following brief account of EKN is based on (Barwise and Cooper 1993), which should be consulted for further explanation and detail.

$$\boxed{\begin{array}{l}\sigma\\ \tau\end{array}}$$

For clarity, single expressions of EKN are often placed in boxes too, e.g.:

$$\boxed{\sigma}$$

The traditional notation used for infons is replaced by a simplified notation which makes them look rather like conditions in DRT. For example, the infon:

$\langle\!\langle \mathrm{eat}, \mathrm{X}, \mathrm{Y}; 1 \rangle\!\rangle$

is written:

$$\boxed{\mathrm{eat}(\mathrm{X},\mathrm{Y})}$$

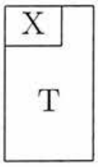
and its dual (the corresponding infon with zero polarity) as:

$$\boxed{\neg\mathrm{eat}(\mathrm{X}, \mathrm{Y})}$$

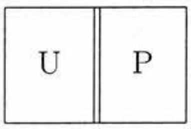
One kind of **proposition** in situation theory is that some infon holds in some situation. This is represented in EKN by tagging the infon box with the name of the situation, to give a proposition box such as:

$$\boxed{\begin{array}{l}\boxed{\mathrm{s}}\\ \mathrm{eat}(\mathrm{X},\mathrm{Y})\end{array}}$$

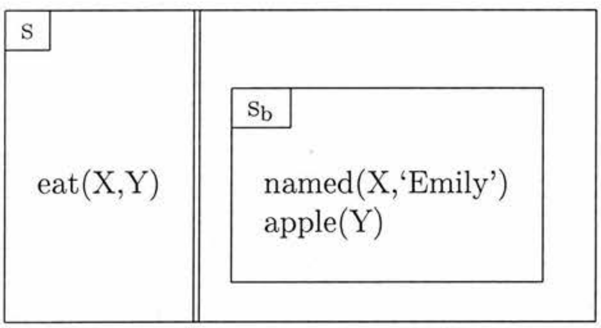
Another form of proposition in situation theory is X:T ("X is of type T"). This is expressed in EKN as:



As we said above, situation theoretic objects can have **restrictions** placed upon them. An infon or a proposition (either parametric or otherwise) is paired with one or more propositions to yield a **restricted object**. Such an object is denoted as below, where U is the original object and P is a proposition that restricts it.



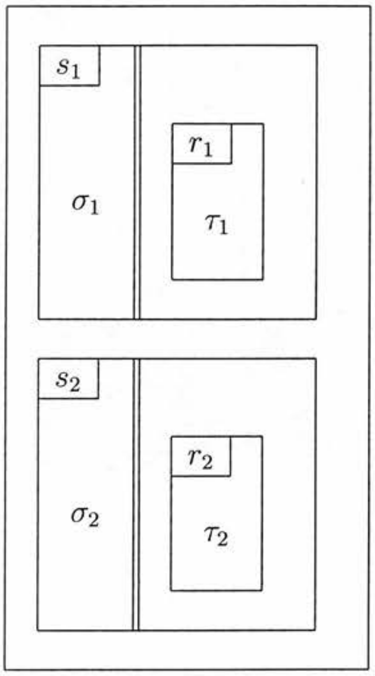
For example, the box:



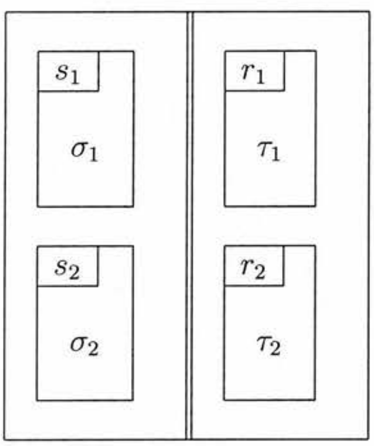
represents a parametric proposition where the parameter X must range over individuals named Emily and the parameter Y must range over objects that are apples.[5]

An important point to note about restrictions is that they distribute over operations such as conjunction (Barwise and Cooper 1993). This means that, for example:

[5] s_b is a background situation that supports the relevant infons. We assume here for simplicity that the same situation supports both infons, but this is not necessarily the case. Also, it should be pointed out that we are not attempting to give a semantics for the indefinite determiner here.



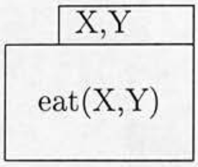
is identical to:



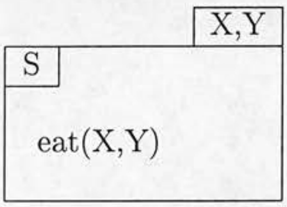
This "floating to the top" of the restrictions will be seen to be important when we look at compositional interpretation.

It is possible to abstract over one or more parameters in any kind of situation theoretic object. The notion of abstraction in situation theory is based on work in (Aczel and Lunnon 1991) and (Lunnon 1991). It is similar to abstraction in the λ-calculus, with the important difference that parameters may be abstracted over simultaneously, as well as serially as in the λ-calculus.

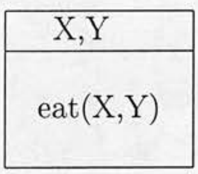
Absracting over one or more of the parameters of a parametric infon gives an abstract called a **relation** (or, if it is unary, a **property**). For example:



Abstracting over one or more of the parameters of a parametric proposition gives an abstract called a **type**. For example:



Infon abstracts (relations or properties) and proposition abstracts (types) can both be used as predicates. This is marked by an alternative notation for these abstracts, shown below.



For simplicity, we will consistently use the latter notation for infon abstracts and proposition abstracts in this thesis.

The possibility of simultaneous abstraction means that it is necessary to identify in some way the argument roles of the abstracts. The argument roles may be indexed simply by the natural numbers, depending on the order of the parameter symbols in the box. Alternatively, if we are thinking of an abstract as corresponding to a natural language utterance, we may wish to index the argument roles by, for example, thematic roles such as 'agent' and 'patient'. Such indexing is shown as follows:

Agent → X, *Patient* → Y
eat(X,Y)

If the roles in an abstract are unlabelled in the notation, this indicates that they are indexed by the natural numbers $(1, \ldots, n)$.

Infon abstracts (relations) and proposition abstracts (types) can be predicated of **assignments**. In the case of an abstract with argument roles which have indices other than natural numbers, an assignment is indicated as follows:

$$\begin{bmatrix} \mathit{Agent} \to a \\ \mathit{Patient} \to b \end{bmatrix}$$

The predication of an assignment by a relation forms an infon, and is shown as follows:

$$\boxed{\begin{array}{|l|}\hline \mathit{Agent} \to \mathrm{X},\ \mathit{Patient} \to \mathrm{Y} \\ \hline \mathrm{like(X,Y)} \\ \\ \hline \end{array} \left(\begin{bmatrix} \mathit{Agent} \to a \\ \mathit{Patient} \to b \end{bmatrix} \right)}$$

3.4 Situation-Theoretic Discourse Representation Theory

3.4.1 Introduction

The EKN presented in (Barwise and Cooper 1993) is a graphical notation for situation-theoretic objects, based on the graphical notation of DRT. Thus one of the things that EKN does is to lay a foundation upon which a theory that combines insights from both situation theory and DRT could be built. In (Cooper 1993c), a proposal is made for combining situation theory and DRT in this way. We will now briefly describe some features of this proposal that are relevant to our fragment.

Cooper proposes that DRSs are viewed as situation-theoretic predicates. The reader will recall from the previous section that both types and relations can be used as predicates in situation theory. In DRT, a DRS such as:

X,Y
own(X,Y) man(X) donkey(Y)

is an expression of a language, which must be interpreted in a model. In situation theory, the above DRS is not a syntactic object but a semantic object: a situation-theoretic relation just like the ones we obtained by abstracting over the parameters of an infon in the previous section. Thus discourse referents in DRT correspond to abstracted parameters (or, more precisely, to the roles obtained by abstracting over parameters).

Situation theory also provides the option of introducing situations into DRSs. Modelling DRSs not as relations but as types gives greater expressive power which Cooper uses in his treatment of the attitudes. We will use it here to allow us to deal with time and events.

In (Kamp and Reyle 1993) a treatment of tense and temporal reference in DRT is given, which uses both event and time referents. (See Chapter 2 for discussion of Kamp and Reyle's temporal fragment.) In their fragment, event referents are related to conditions using the following notation:

e: $\boxed{\text{write(x,y)}}$

where x and y are discourse referents corresponding to individuals, and e is an "event" discourse referent. Kamp and Reyle explain that this is an alternative notation for the condition:

climb(e,x,y)

where e is an event argument as proposed by Davidson (1967) and adopted since by others.[6]

Kamp and Reyle explain that their notation:

e: $\boxed{\text{write(x,y)}}$

is intended to reflect the fact that e has a different status from the other discourse referents, x and y, in the condition. They suggest that it may be right to see conditions like write(x,y) as specifying the **type** of the event e (see Kamp and Reyle 1993, p.111). However, this idea that e is of type write(x,y) is not captured in their semantics. The interpretation of the condition:

e: $\boxed{\text{write(x,y)}}$

is the same as that of:

write(e,x,y)

— that is, the model interprets the verb 'write' as having an extension which is a set of triples $\langle E, a, b\rangle$, where E is an event and a and b are individuals (see Kamp and Reyle 1993, p.665). Thus the idea — which is a very intuitive one — that an event is of a certain type is not given a semantic interpretation in DRT.

Introducing situations via STDRT allows us to give a precise semantics for the notion of an event being of a certain type. In situation theory, if a situation s supports an infon σ then we say that s is of type σ. Thus, if we model events (and states) as situations, and see conditions as corresponding to infons, we can interpret:

e: $\boxed{\text{write(x,y)}}$

as meaning that the situation e supports the infon write(x,y), i.e.:

e $\models$ write(x,y).

Thus the use of situations gives us a very natural and straightforward semantics for Kamp and Reyle's intuition about the meaning of conditions involving events.

[6] Kamp and Reyle differ from Davidson's proposal, however, in that Davidson proposed that only event predicates, not states, should have an event argument, whereas Kamp and Reyle follow Parsons (1990), for example, in giving an eventuality argument to all predicates.

The STDRT framework allows us to use DRT's treatment of anaphora (as we did in the fragment presented in Chapter 2) together with the notion of events (and states) as situations provided by situation theory. The latter allows us to incorporate information about event structure, aspectual class and discourse relations into our grammar. In other words, DRT's facility for handling anaphora will allow us to capture the behaviour of 'then' as a temporal anaphor, while situation theory's rich ontology of situations, infons, etc. will allow us to express information about event structure that will allow us to give a treatment of aspectual composition and the like.

3.4.2 Discourse processing in DRT

In conventional DRT, the processing of a new sentence (or clause) builds on the pre-existing DRS by adding new condition(s) and (possibly) new discourse referents to the pre-existing DRS. Thus, for example, the sequence:

(3.1) a. A boy bought a donkey

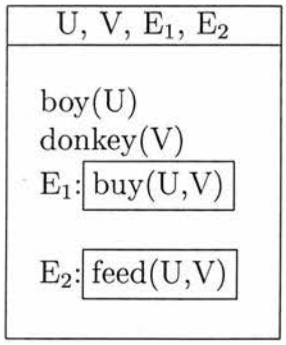
b. He fed it

would be processed as follows. Sentence (3.1a) would be parsed according to syntactic rules and the resulting parse tree would be subject to the operations of the construction rules in such a way as to produce the DRS:

$$\begin{array}{|l|}\hline \text{U, V, E}_1 \\ \hline \text{boy(U)} \\ \text{donkey(V)} \\ \text{E}_1\text{:}\boxed{\text{buy(U,V)}} \\ \hline \end{array}$$

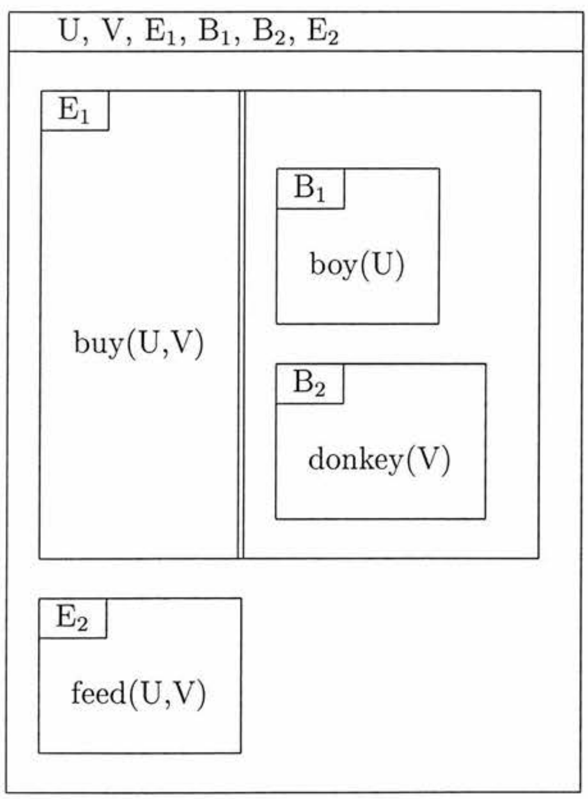
(Note: we ignore matters of tense for the time being.)

The processing of (3.1b) would add new conditions to the DRS to give:



3.4.3 Discourse processing in STDRT

In STDRT however, each sentence corresponds to the introduction of a new proposition. The DRS for a discourse is the type formed by combining[7] the types corresponding to each individual sentence. In EKN, the representation for the above discourse would be (again, ignoring tense):



We noted earlier that restrictions distribute over conjunction and other closure

[7]In a way that we will discuss below

operators that do not abstract over or substitute for parameters (see Section 3.3). This means that the above type is identical to:

U, V, E_1, B_1, B_2, E_2	
E_1 buy(U,V)	B_1 boy(U)
E_2 feed(U,V)	B_2 donkey(V)

We should explain here how the current DRS is incremented by adding to it the type corresponding to the latest sentence to be processed. Cooper defines an operation of predicate conjunction, $\oplus$, which increments a DRS with another DRS. This is best illustrated by the following example, taken from (Cooper 1993c, page 23]:

$i \rightarrow X, j \rightarrow Y$		$i \rightarrow X, k \rightarrow Y$
r(X,Y)	$\oplus$	r′(X,Y)

The idea is that if two predicates are conjoined by $\oplus$, any roles that have the same index in the two predicates will end up being assigned to the same parameter in the conjunction. Thus anaphora can be captured by the sharing of roles, which results in the sharing of parameters.

Consider the two conjuncts above. Abstraction over a parameter means of course that the parameter effectively "disappears", leaving the corresponding role. Thus:

X
run(X)

and

Y
run(Y)

represent the same situation-theoretic object. In attempting to conjoin the two abstracts in our example, what is taken into account is thus not the names of the parameters but the names of the roles. Because the *i*-role is shared across the two conjuncts, this role will end up being assigned to the same parameter in the conjunction. And because the *j*- and *k*-roles are distinct, these will be assigned to different parameters, giving:

i → X, j → Y, k → Z
r(X,Y) r′(X,Z)

The formal definition of $\oplus$ given by Cooper (1993c) is as follows:

Definition:

> If ζ is a predicate with role indices $r_{\zeta 1}, \ldots, r_{\zeta n}$, ξ is a predicate with role indices $r_{\xi 1}, \ldots, r_{\xi m}$ and f is an assignment whose domain $\{r_1, \ldots, r_k\} = \{r_{\zeta 1}, \ldots, r_{\zeta n}\} \cup \{r_{\xi 1}, \ldots, r_{\xi m}\}$
> which assigns a unique parameter X_i to each r_i in its domain then:

$$\zeta \oplus \xi = \begin{array}{|l|}\hline r_1 \to X_1,\ \ldots,\ r_k \to X_k \\ \hline \zeta f \\ \xi f \\ \hline \end{array}$$

We will now go on to describe how our grammar was developed by incorporating ideas from Cooper's STDRT into STG (Cooper 1991) and by extending STG to include temporal information.

Before we do this, it should be noted that there is an important difference between Cooper's STG and his STDRT as described in (Cooper 1993b, 1993c). In STG, syntactic and semantic information are placed side by side in the grammar rules, and processed in parallel. Rather than produce a syntactic parse and then go on to interpret this using rules of interpretation (as, for example, do the grammars of (Kamp and Reyle 1993)), syntactic and semantic information are processed together to give the interpretation of the utterance. In this respect STG is similar to, for example, HPSG (Pollard and Sag 1987). In STDRT, on the other hand, Cooper is attempting to recreate Kamp and Reyle's fragments where syntax and sematics are treated sequentially. The interpretation rules of STDRT therefore presuppose a complete syntactic parse, just as do the construction rules of Kamp and Reyle's fragment.

In our grammar, DSTG, we are making a preliminary attempt to build discourse processing into STG. For this reason, our rules will look rather like those of STG and will contain a mixture of syntactic and semantic features. We will, however, make use of one of the central ideas of STDRT, which is that DRSs can be thought of as situation-theoretic types. We will also use the notion of "threading" information through a sentence (which was originally suggested by Johnson and Klein (1986)) in a way similar to that used in STDRT. But our rules will look much more like STG rules than STDRT ones.

3.5 Situation Theoretic Grammar

3.5.1 Introducing STG

Our grammar is based on the situation theoretic grammar (STG) developed in Cooper 1988a and Cooper 1991. In (Cooper 1988a) a grammar is defined to be:

> "A partial characterization of a relationship between utterance situations and other situations, about which they carry partial information."

(Cooper 1988a, p.23).

Cooper expresses this relationship as:

$\mathrm{gr}(u, \pi, env)$

where 'gr' is the grammar relation, u is the use of a linguistic expression, π is a parametric infon (that is, an infon whose arguments are parameters) and *env* is an environment which provides anchors for the parameters of the infon.[8]

Cooper also divides the grammar relation 'gr' into a group of more specific grammar relations including 's', 'vp', 'np' etc., corresponding to the relevant grammatical categories. He defines phrase structure rules in terms of these grammar relations. Each constituent is associated with partial information about an infon and an environment. Constituent combination requires identity or compatibility between the infons and environments of the combining constituents and the resulting constituent.

For example, Cooper's top-level "sentence" rule is as follows:

$$
\begin{aligned}
&\mathrm{s}(\underline{[NP\ \ VP]_S}, \pi, env) \text{ if}\\
&\quad \mathrm{np}(\underline{NP}, subj, \pi, env)\\
&\quad \mathrm{vp}(\underline{VP}, \pi, env)\\
&\quad \underline{NP} \models [case : \mathrm{nom}]
\end{aligned}
$$

This rule is to be interpreted as follows. As mentioned above, the 'gr' relation (in this case the 's' relation) holds between an utterance situation corresponding to the use of a linguistic expression, a parametric infon, and an environment. Uses are represented by underlining; thus $\underline{VP}$ is the use of the verb phrase. The relation 'np' has an extra argument corresponding to the grammatical function "subject". Utterance situations corresponding to uses of linguistic expressions support information about, for example, case, number and gender. Here, the use of the NP supports the information that its case is nominative. Such information allows the rules to incorporate syntactic features such as agreement among constituents. As such features are functional (single-valued), the representation is in the form of sets of feature:value pairs.

[8]An anchor in situation theory assigns values to parameters. It thus differs from an assignment, which assigns values to roles of an abstract. The idea is that parametric objects are seen as generalisations over classes of non-parametric objects. The parameters of a parametric object could be associated with objects called anchors. Replacement of a parameter in a parametric object by its anchor would yield an object belonging to the class that the parametric object abstracts over. (This explanation is based on the one in (Cooper 1991), which should be consulted for further details.)

Cooper's grammar consists of a lexicon and a set of phrase structure rules. The lexical entry for 'likes' is given below:

likes:

$$
\begin{array}{l}
\mathrm{v}(u, \ll \mathrm{R}, \mathrm{X}, \mathrm{Y}; 1 \gg, env) \text{ if} \\
\quad u \models \begin{bmatrix} \text{use-of:} & \text{'likes'} \\ \text{category:} & \mathrm{V} \end{bmatrix} \\
\quad env \models [[u, \mathrm{pred}] : \mathrm{R}/\mathrm{like}, [u_1, \mathrm{subj}] : \mathrm{X}/x, [u_2, \mathrm{obj}] : \mathrm{Y}/y] \\
\quad u_1 \models [\text{ person: third }]
\end{array}
$$

Lexical entries for verbs introduce the structure of the infon. Because 'likes' is transitive, there are parameters X and Y corresponding to the first and second arguments of the relation.

u is the utterance situation corresponding to a use of the verb. It supports the information that there is a use of the word 'likes' and its category is V. The information supported by *env* is to be interpreted as follows. The notation:

[u,pred]: R/like

signifies that the parameter R of the infon is **labelled** by the utterance situation u and also by the grammatical function 'pred' (predicate). The notion of labelling is a precursor of the idea of role indexing, introduced above. An anchoring environment in Cooper's STG supplies not only anchors for parameters but **labels** which are used to point at a particular parameter. In principle, any kind of situation-theoretic object could be used to label a parameter. In Cooper's grammar both utterance situations and grammatical relations are used for this purpose.

The above expression also signifies that the parameter R is anchored to the relation 'like'.

The notation:

[u,pred]: R/like

is actually an abbreviation for:

$\ll \mathrm{anchor}, \ll \mathrm{R}, \mathrm{X}, \mathrm{Y}; 1 \gg, \mathrm{R}, \{u, \mathrm{pred}\}, \mathrm{like}; 1 \gg$

where 'anchor' is a relation that holds between a parametric infon, a parameter, one or more labels for that parameter, and exactly one anchor for that parameter.

In Cooper's STG, the environment may support information other than the provision of labels and specific anchors. For example, restrictions may be placed on the objects to which a parameter may be anchored. This is best illustrated by the lexical entry for a proper name, 'Anna'.

Anna:
$\mathrm{n}(u, gf, \pi(X), env)$ if

$$u \models \begin{bmatrix} \text{use-of:} & \text{`Anna'} \\ \text{category:} & \text{N} \\ \text{person:} & \text{third} \end{bmatrix}$$

$$env \models [[u, \mathrm{gr}] : \mathrm{X}/x],$$
$$env \models \ll \text{named}, x, \text{`Anna'}; 1 \gg$$
$$env \models \ll \text{female}, x; 1 \gg$$

Note that there is an argument place here for the grammatical function 'gf', which is unspecified as 'Anna' may be used as either the subject or object of a sentence.

Env supports information to the effect that X may only be anchored to an individual named 'Anna' who is female.

Our DSTG grammar rules for intra-sentential processing are based upon those of Cooper's STG described above. However, in addition to extending the rules to process discourse and include temporal information, we have introduced modifications in the light of recent developments in situation theory that have occurred since Cooper's original grammar was developed. For example, the notion of abstraction over parameters in parametric objects was not well developed in the version of situation theory used by Cooper for STG. We have modified the 'infon' (π) argument of the grammar relation to be a type instead of an infon.[9]

Restrictions are also treated rather differently. Rather than having a single situation *env* to support restrictions on anchors for parameters, a restricted object is now formed (as described in Section 3.3) by combining restrictions with an object such as an infon or proposition. The restrictions consist of a set of propositions, and may involve more than one situation. A restricting proposition may, as we discussed earlier, place restrictions on the kind of objects over which a parame-

[9]It was suggested in (Cooper 1991) that ultimately it might be preferable to use a proposition rather than an infon to represent the interpretation of a sentence.

ter may range. Thus current notions are intuitively similar but formally rather different from those used in (Cooper 1991).

In our grammar, which uses EKN, the restrictions form part of the 'type' argument and may involve more than one situation. Thus we do not need the *env* argument to support information, say, about names. We still, however, need to express information about the labelling of parameters, or some similar notion. But by using a type rather than an infon, we can index the roles of the type with utterance situations and grammatical functions. We therefore use role indexing instead of parameter labelling, and this allows us to dispense entirely with the argument *env*.

The above changes do not actually make a great deal of difference to the way that the grammar works. The phrase structure rules and lexical entries are expressed in a similar format to those of Cooper's STG. Grammatical processing once again is based upon compatability between information associated with the constituents and their combined use. Processing of an individual sentence produces a type which includes restrictions on, for example, the objects to which roles of the type may be assigned. Processing of a discourse composed of one or more sentences produces a DRS/type derived from the conjunction of types derived from the individual sentences. We will describe this in detail shortly.

We have extended the STG rules to deal with both temporal constructions and the processing of discourse. Before discussing these extensions we will address in detail some issues concerning the representation of temporal information in situation theory.

3.5.2 The extension of Cooper's STG fragment to include temporal information

Introduction

Cooper's original STG did not cover temporal reference. The verbs were all present tense and no temporal information was present in the rules. An extended version of Cooper's grammar was developed by Glasbey (1990). Here, the implemented version of STG (known as ProSit) was expanded to include past and future tenses, perfects, progressive aspect, various aspectual classes, aspectual modification and temporal adverbials. This grammar was, however, limited to single sentences and did not process discourse. Temporal information was incorporated by giving each relation an extra argument l corresponding to spatiotemporal location. The idea of using a single argument for spatiotemporal location rather than separate arguments for time and place was prompted by early work in situation semantics (Barwise and Perry 1983) and by the treatment of aspectual classes in situation semantics in (Cooper 1985) and (Cooper 1986).

The motivation for using l rather than separate time and place arguments has been questioned by Crow (1990). Crow argues that there is little linguistic evidence supporting the need for four-dimensional space-time "chunks" in the ontology of situation theory. She argues (as have others, such as Devlin (1991)), that natural language constructions almost always apply to either temporal or spatial regions but not both. Crow discusses a few examples where spatiotemporal locations might possible be needed, such as events, trips, holidays and so on, including the example from (Cooper 1985):

(3.2) It did not snow on the trip from Madison to Chicago

Crow points out, however, that spatiotemporal locations may not even be necessary in these cases. For example, as Cooper (1985) suggests, the semantics for an NP such as 'the trip' could involve seeing the denotation of the NP as a set of space-time pairs.

Crow argues in favour of regarding time and place roles as (separate) argument roles of relations. This does not, however, presuppose that every relation will necessarily have a time role, a place role, or both.

It seems there is a need for more detailed investigation here. One approach that might be taken is to look at which relations possess which argument roles. If it could be shown, for example, that there are some relations which have time roles but not place roles, then this would suggest that we should consider time and place roles separately. Of course, this raises the question of how we are to tell which relations possess which roles. One way of answering this might be to look at temporal and spatial anaphora. We will consider this issue further below.

Another issue worth investigating might be that of whether time, place or spatio-temporal locations should be considered as argument roles of relations at all. An alternative would be, for example, to regard infons not as unary types of situations but as binary types of situations and times, or as ternary types of situations, times and places. There would be no problem in expressing this in situation theory, which can remain neutral on this issue. The question appears to depend, rather, upon the particular application. We simply wish to note that it should not be taken as a foregone conclusion that times are argument roles of relations, but that linguistic evidence may well be relevant in making this decision. The topic is one that may be taken up in future work.

Since we have decided to stick with relations having time and place roles for the present, we now need to consider whether or not every relation actually has such roles. In the following section we will consider various pieces of linguistic evidence that bear on this.

We will consider for simplicity here that if a relation has a time (or place) role, then an eventuality involving this relation will also have a time (or place) role, and vice versa. Thus we will speak about testing for the presence or otherwise of time and place roles associated with eventualities.

Thus, T can be thought of as the eventuality time of S. If the relation has a time role, then the eventuality will also have a time role. If the relation lacks a time role, the eventuality will lack one too. If on the other hand we use timeless relations, then the question becomes one of whether a given infon is a binary type of situations and times, or a unary type of situations. So whichever option we take, the question is really one of whether the eventuality in question is associated with a time, or not. We will thus rephrase our initial question and ask which eventualities have time (and place) roles and which do not.

Linguistic tests for which eventualities have time and/or place roles

Testing for time roles

One obvious test for the presence of a time role associated with an eventuality is whether or not it is possible to specify the time at which the eventuality occurred or held. For example:

(3.3) Daniel liked rugby last year

(3.4) Emily played football yesterday

(3.5) John climbed Snowdon last week

(3.6) Mary finished her chapter at 5pm

Here we have a state, an activity, an accomplishment and an achievement respectively, each of which is modified by a temporal adverbial. Thus it seems clear that each of these eventualities has a time role. Of course, we say above that we will need more than one time role for a given type of eventuality, and we will need further tests to determine exactly which time roles are needed. However, we do not propose to do this here. Our purpose here is simply to establish that time roles seem to be ubiquitous to eventualities. It is difficult to imagine this being other than the case.

Testing for place roles

Now let us try to do the same thing for place.

(3.7) Daniel liked rugby in Wales

(3.8) Emily played football in the park

(3.9) ? John climbed Snowdon in Wales

(3.10) Mary finished her homework in the study

At first glance, (3.7) seems to confirm that the described state has a place role. But we need to be careful here. It is possible that the meaning of (3.7) is something akin to:

(3.11) Daniel liked rugby when he was staying in Wales

or perhaps:

(3.12) Daniel liked watching rugby that was played in Wales

In (3.11), rather than being a spatial modifier, 'in Wales' appears to be acting as a kind of hidden temporal modifier. Cooper (1985) introduces such cases in a discussion of whether stative relations have place arguments.

The uncertainty here suggests that we should look for other tests. One possibility is to use spatial anaphora. If it is possible to use 'there' to refer back to a spatial location established by a previous sentence, then the eventuality described in that sentence must surely have a place role.

However, an investigation into 'there' as spatial anaphor reveals that it requires the presence of an explicit spatial referent (ESR). It thus shows a parallel with ETR-'then'.

For example:

(3.13) a. Jane made a parachute landing

b. Bill landed there (too)

sounds extremely odd. Yet if we add an ESR:

(3.14) a. Jane made a parachute landing in the middle of a field

b. Bill landed there too

the sequence becomes perfectly acceptable. Thus it seems that 'there' is not a test for place roles in general, because it can only refer back to explicit spatial referents.[10]

We can, however, use 'at the same place'.

(3.15) a. Jane made a parachute landing

b. Bill landed at the same place

The acceptability of (3.15a,3.15b) strongly suggests that the event described in (3.15a) has an associated place role. 'Nearby' appears to work in the same way as 'at the same place' by not requiring an ESR.

Now consider:

(3.16) a. Daniel liked rugby

b. Owen liked rugby at the same place

It appears that (3.16a,3.16b) can only be interpreted if we take the reading where Daniel liked rugby when he was staying at a certain place, and that Owen liked

[10]More work is required on 'there'. We will say a little more about this in Chapter 6.

rugby when he was at that same place. Or perhaps, that Daniel liked watching rugby played at Murrayfield, and Owen like watching rugby played at Murrayfield too. But of course in this latter case it is the playing events that are located at Murrayfield, not the states of liking. This issue clearly relates to that of PP-attachment — whether the PP 'at the same place' attaches to the NP 'rugby' or to the VP (or to S), for example.

Thus we have some evidence here that some states, at least, do not have place roles. We do not, however, consider the evidence to be conclusive. It may not be possible to generalise over states in this way, and we should remain open to the possibility that some states have place roles while others do not. This issue is considered further in (Glasbey 1994a).

Example (3.17) is interesting.

(3.17) ? John climbed Snowdon in Wales

The reason we marked (3.17) with a question mark is that it sounds rather odd unless we take it to mean that John climbed Snowdon when he was in Wales, or alternatively, that we take 'in Wales' to modify 'Snowdon'. This, of course, is similar to the stative case and suggests that the event described here does not have a place role. But it seems very odd to think of a climbing event not having a place role. Intuitively, a climb must be spatially located, while a 'liking', one feels, need not. Note that:

(3.18) John climbed in Wales

is perfectly fine.

Let us examine the sequences with 'at the same place'.

(3.19) a. John climbed Snowdon
b. Owen climbed Snowdon/it at the same place

Once again, this sounds very odd, while:

(3.20) a. John climbed
b. Owen climbed at the same place

sounds fine.

What seems to be happening here is that the argument labelled 'Snowdon' is somehow getting in the way of being able to specify the place role. This makes sense if we see the direct object argument 'Snowdon' filling the place role itself and thus making it impossible to fill it again. Presumably this is possible because 'Snowdon' names an object that is also a place.

Conclusion

Our brief excursion into the evidence for time and place roles has led us to the conclusion that while all eventualities appear to have time roles, it is at least possible that states do not have place roles. Thus our findings suggest that it is preferable to use separate time and place roles rather than a single role for spatiotemporal location.

We therefore propose to give separate time and place roles to eventualities.

Before we introduce the grammar there is one further issue we must consider — that of exactly how situations and times are related. Let us consider what the proposition:

$$\begin{array}{|c|}\hline \boxed{\mathrm{S}} \qquad \\ \\ \sigma \\ \\ \hline\end{array}$$

allows us to say about the temporal properties of S. Can we, for example, associate S in some way with T? Clearly, this depends on what other infons S supports. Remember that S may be a "big" situation which supports many more infons that just σ. To give a concrete example, suppose we have:

S	R
climb(X, Y, T)	named(X,'Daniel') named(Y,'Ben Nevis')

Here, S may be the situation we might call "Daniel's climbing Ben Nevis" — that is, it supports the infon $\boxed{\text{climb(X,Y,T)}}$ and (perhaps) little or nothing else. But S could also be a much larger situation — for example, the situation that comprises Daniel's school trip to Fort William, or even the much larger situation we might call "Daniel's life". Obviously T does not give us any information about the duration of these latter two situations. But it seems correct to say that T tells us something about the temporal duration of the situation we can think of as Daniel's climb of For example, S$'$ may be required to support the infon $\boxed{\text{walk(X,T}')}$, if we consider it impossible for someone to climb a mountain without walking.

One way around this problem is to use the notion of "key infon" introduced in (Cooper 1985). Cooper defines a key infon of a situation S as follows:

Definition:

> A **key infon** is an infon (supported by a situation S) whose temporal duration includes those of all the other infons supported by S.

Cooper allows there to be more than one key infon for a given situation, in which case the key infons would have the same temporal durations. We could express this as a binary type KEY holding between a situation S and an infon $\sigma(T)$, where the notation $\sigma(T)$ indicates that the infon σ contains the parameter T.

Then we can say:

$S, \sigma(T) : \text{KEY} \rightarrow S, T : \text{TIME-OF}$

where TIME-OF is a type of a situation S and a time T such that T can be thought of as the temporal duration of S.

We define an eventuality (or a situation of type EVENTUALITY) as follows:

Definition:

An **eventuality** is a situation that has at least one key infon. We say that such a situation is of type EVENTUALITY.

3.6 DSTG: The Extension of STG to Discourse

3.6.1 Coverage of the fragment

Our grammatical fragment generates the discourse sequences (3.21a,3.21b), (3.21a,3.21c), (3.21a,3.21d) and (3.21a,3.21e).

(3.21)
a. Daniel climbed Ben Nevis in July
b. Owen climbed Snowdon then
c. Owen was climbing Snowdon then
d. Owen liked Daniel then
e. Then Owen climbed Snowdon

It also generates the sequences (3.22a,3.22c), (3.22a,3.22d), (3.22a,3.22e), but disallows (3.22a,3.22b), just as in the DRT fragment we gave in Chapter 2.

(3.22)
a. Daniel climbed Ben Nevis
b. Owen climbed Snowdon then
c. Owen was climbing Snowdon then
d. Owen liked Daniel then
e. Then Owen climbed Snowdon

The coverage is thus the same as that of the DRT fragment of Chapter 2. For simplicity, we have retained the syntactic form of the rules from the DRT fragment. However our rules are written in the form of Cooper's STG (Cooper 1991), and thus contain both syntactic and semantic features. DSTG, like STG, does syntactic and semantic processing concurrently, which means that processing of a sentence or sequence of sentences results directly in the construction of a semantic representation expressed in EKN notation. As we explained earlier, this is unlike Kamp and Reyle's DRT and Cooper's STDRT, where a complete syntactic parse is obtained first, followed by semantic interpretation. DSTG differs from STDRT in another important way: in STDRT, Cooper uses Montague-style application to combine interpretations of constituents, whereas in DSTG we use Cooper's $\oplus$ operator (see Section 3.4.3) in order to combine interpretations. We will explain how this works shortly.

We will first present the phrase structure rules in simplified form in order to show the basic syntax of the fragment. Then we will explain some of the complete rules and lexical entries in detail and show how discourse processing is achieved.

3.6.2 Syntactic rules

In order to process sequences of sentences, we introduce a top-level recursive discourse rule:

$\mathrm{Dis} \rightarrow \mathrm{S}', \mathrm{Dis}$

The introduction of such a rule is equivalent to assigning a "tree structure" to discourse, along the lines of, for example, (Polanyi and Scha 1984). The decision to assign this kind of structure to discourse was made for reasons of processing simplicity, as the required recursive rule is easily introduced into a definite-clause grammar (DCG). The grammar was designed with implementation in Prolog in mind, along the lines of Cooper's implementation of STG called ProSit, described in (Cooper 1988b) In fact, a grammar similar to the one we present here but containing some additional features including aspectual composition has been implemented in Prolog, and is described in (Glasbey 1993c).

We do not consider here the alternative possibilities for discourse structure, although we do not intend to rule them out of consideration.

We make our top-level sentence category S′ rather than S in order to deal with sentential adverbials (see below). We follow Kamp and Reyle (forthcoming) in treating all the adverbials in this fragment as sentential. This treatment of adverbials as sentential appears to be appropriate for 'then' but of course would not be appropriate for all adverbials. In a larger fragment, a rule such as:

$\mathrm{V}' \rightarrow \mathrm{V}', \mathrm{AdvP}$

would need to be added. The recursive nature of this rule allows the grammar to parse sequences of adverbials.[11]

The base of the recursion is covered by the rule:

$\mathrm{Dis} \rightarrow \mathrm{S}'$

Thus our grammar will parse (or generate) discourse sequences containing an indefinite number of sentences.

Moving down the parse tree, the next rule we require is:

$\mathrm{S}' \rightarrow \mathrm{S}, \mathrm{AdvP}$

This will, of course, only deal with sentences containing just one sentence-final adverbial. In order to deal with sentence-initial 'then' we need the rule:

$\mathrm{S}' \rightarrow \mathrm{AdvP}, \mathrm{S}$

and, for sentences without adverbials:

$\mathrm{S}' \rightarrow \mathrm{S}$

We will analyse 'S' as being composed of 'NP' and 'VP', i.e.:

$\mathrm{S} \rightarrow \mathrm{NP}, \mathrm{VP}'$

Although our fragment does not include the future 'will' or other modals, we will design the grammar in order to allow these to be added if the fragment is extended. Thus we will use the rule:

$\mathrm{VP}' \rightarrow \mathrm{VP}$

which leaves us room to add modals if we require, by adding a rule such as

[11] The syntax and semantics of sequences of temporal adverbials is by no means straightforward, however, and we do not mean to suggest that the addition of this rule would solve all the problems.

$\mathrm{VP}' \to \mathrm{Mod}, \mathrm{VP}$

In order to analyse the progressive we will follow Kamp and Reyle in using a recursive rule:

$\mathrm{VP} \to \mathrm{Aux}, \mathrm{VP}$

and for transitive verbs:

$\mathrm{VP} \to \mathrm{V}, \mathrm{NP}$

and intransitives:

$\mathrm{VP} \to \mathrm{V}$

The only kind of NPs we have in our fragment are proper names, so we will simply need the rule:

$\mathrm{NP} \to \mathrm{N}$

Our AdvP rule for 'then' is:

$\mathrm{AdvP} \to \mathrm{Adv}$

and for 'in'-adverbials we require:

$\mathrm{AdvP} \to \mathrm{Prep}, \mathrm{NP}(\mathrm{temp})$

Our modification of STG for discourse processing involves the idea of "threading" discourse referents from left to right through the discourse. This notion is taken from (Johnson and Klein 1986), where the authors use it to deal with pronominal anaphora in a declarative implementation of DRT. We are concerned here only with temporal anaphora and do not attempt to deal with pronouns. However, our rules could be extended in a reasonably straightforward manner to deal with pronominal anaphora.

We use a pair of arguments *in* and *out* which are passed from NP to VP′ in a given sentence and also passed on to successive sentences in the discourse. *in* is a set whose members are the discourse referents introduced by the parsing of the discourse so far. Parsing of the current constituent may cause modification of *in* to give an updated list of referents *out* which will be the input to parsing of the next constituent. This left-to-right flow of information is based on that used by Johnson and Klein (1986) and is also employed in (Cooper 1993c), where it is referred to as the 'Pereiran flow' of information, after the work of Fernando Pereira (Pereira 1982).

At the beginning of a discourse, *in* will be the empty set. If we are in the middle of a sequence of sentences, *in* will consist of the set of discourse referents that have been introduced by processing the discourse up to this point. Thus the processing of a given constituent takes place with reference to the value of *in* at that point.

By this means we can keep track of temporal referents introduced by the discourse so far in a way that is necessary for the processing of temporal anaphora with 'then'. Of course, we could also keep track of other, non-temporal discourse referents in this way if we wanted to, but we do not treat pronominal anaphora in this fragment. Note, too, that our approach allows a temporal anaphor to refer back to a temporal referent introduced earlier in the same sentence. Although our fragment does not contain any such examples, this means that it could be extended relatively simply if we wanted to introduce such sentences.

3.6.3 Summary of syntax

For convenience, we present here the set of rules of the grammar, stripped of most of their features.

$\mathrm{Dis} \to \mathrm{S}', \mathrm{Dis}$

$\mathrm{Dis} \to \mathrm{S}'$

$\mathrm{S}' \to \mathrm{S}, \mathrm{AdvP}$

$\mathrm{S}' \to \mathrm{AdvP}, \mathrm{S}$

$\mathrm{S}' \to \mathrm{S}$

$\mathrm{S} \to \mathrm{NP}, \mathrm{VP}'$

$\mathrm{VP}' \to \mathrm{VP}$

$\mathrm{VP} \to \mathrm{Aux}, \mathrm{VP}$

$\mathrm{VP} \rightarrow \mathrm{V(trans), NP}$

$\mathrm{VP} \rightarrow \mathrm{V(intrans)}$

$\mathrm{NP} \rightarrow \mathrm{N}$

$\mathrm{AdvP} \rightarrow \mathrm{Adv}$

$\mathrm{AdvP} \rightarrow \mathrm{Prep, NP(temp)}$

$\mathrm{Adv} \rightarrow \{\mathrm{then}\}$

$\mathrm{N} \rightarrow \{\mathrm{Daniel, Owen, Emily, Fiona, BenNevis, Snowdon, July}\}$

$\mathrm{V} \rightarrow \{\mathrm{climbed, liked, ran, climbing, running}\}$

$\mathrm{Prep} \rightarrow \{\mathrm{in}\}$

$\mathrm{Aux} \rightarrow \{\mathrm{was}\}$

3.6.4 Lexical entries and grammar rules

We begin by presenting our lexical entry for the verb 'liked'. For comparison, we will repeat the entry for 'likes' from Cooper's STG in (Cooper 1991).

likes:

$$
\begin{array}{l}
\mathrm{v}(u, \langle\!\langle \mathrm{R}, \mathrm{X}, \mathrm{Y}; 1 \rangle\!\rangle, env) \text{ if} \\
\quad u \models \begin{bmatrix} \text{use-of:} & \text{`likes'} \\ \text{category:} & \mathrm{V} \end{bmatrix} \\
\quad env \models [[u, \mathrm{pred}] : \mathrm{R}/\mathrm{like}, [u_1, \mathrm{subj}] : \mathrm{X}/x, [u_2, \mathrm{obj}] : \mathrm{Y}/y] \\
\quad u_1 \models [\text{ person: third }]
\end{array}
$$

We explained the meaning of this entry in Section 3.5.1.

Our entry for 'liked' looks rather different. This is partly because we have used the situation-theoretic notions of type, abstraction and role-indexing which were not available when STG was developed. However, DSTG rules are closely related to STG rules, as will become clear when we explain them below.

First, a note about notation. In all the lexical entries and rules below, variables are denoted by italics (e.g. x), parameters in uppercase Roman font (e.g. X) and constants in lowercase Roman (e.g. c).

Our lexical entry for 'liked' is as follows:

liked:
(u, utt, ty, f, in, out):v
where ty is:

$$\begin{array}{|l||l|}
\hline
\multicolumn{2}{|c|}{[\mathrm{subj}, u_1] \to \mathrm{X},\ [\mathrm{obj}, u_2] \to \mathrm{Y},\ [\mathrm{pred}, u] \to \mathrm{R},\ [\mathrm{ev}, u_3, utt] \to \mathrm{S},\ [\mathrm{time}, utt] \to \mathrm{T}} \\
\hline
\boxed{\mathrm{S}} & \\
\mathrm{R(X,Y,T)} & \begin{array}{|l|}\hline \boxed{\mathrm{S,R(X,Y,T)}} \\ \mathrm{KEY} \\ \hline \end{array} \quad \begin{array}{|l|}\hline \boxed{\mathrm{S}} \\ \mathrm{STATE} \\ \hline \end{array} \\
\hline
\end{array}$$

if:

$[[\mathrm{pred},u] \to \mathrm{like}] \subseteq f$

$$u \models \begin{bmatrix} \text{use-of:} & \text{'liked'} \\ \text{cat:} & \{\mathrm{v}\} \\ \text{trans:} & \mathrm{pos} \\ \text{aspect:} & \mathrm{simple} \\ \text{time-ref:} & \mathrm{past} \end{bmatrix}$$

$$u_1 \models \begin{bmatrix} \text{cat:} & \{\ldots,\mathrm{np}\} \end{bmatrix}$$

$$u_2 \models \begin{bmatrix} \text{cat:} & \{\ldots,\mathrm{np}\} \end{bmatrix}$$

$$u_3 \models \begin{bmatrix} \text{ev-type:} & \mathrm{state} \end{bmatrix}$$

$out = in \cup \{[\mathrm{ev},u_3,utt], [\mathrm{time},utt]\}$.

In place of Cooper's grammatical relations (s, vp, np, v, n, etc.) in STG, which hold between an utterance (situation) of a constituent, an infon and an environment, we use a 6-place type (e.g. v) to express this information. The lexical entry above states that type v holds of the 6-tuple comprising an utterance of a constituent (u), the utterance of the whole sentence (utt), a type (ty), an assignment (f) and the sets of ingoing and outgoing discourse referents for that constituent (*in*, *out*), provided that certain specified conditions hold. These include a specification of the type *ty* introduced by the verb 'liked' (which replaces the infon used in STG, and contains additional aspectual information), a specification of what information is supported by utterances of other constituents of the sentence (u_1, u_2, etc.), information about the assignment, and a specification of how *out* relates to *in*.

The information that was supported by *env* in STG is now expressed in other ways. Information about the labelling of parameters by constituent uses and grammatical functions is expressed by the indexing of the roles of *ty*. For example, this role-indexing tells us that the role obtained by abstracting over parameter X is indexed by the grammatical function 'subj' and by the utterance u_1. *Env* in STG also supported information about restrictions on the objects to which parameters could be anchored. This information is now incorporated into the restrictions of *ty*.

Note that while the roles corresponding to parameters X, Y, R are indexed firstly by a grammatical function and secondly by an utterance of a constituent, the roles corresponding to S and T are slightly different. Let us consider T first. T is meant to represent the "eventuality time" of the state described by the whole utterance. But we have seen that such an eventuality time is never phonologically realised in an utterance (see Section 3.5.2). This means that there is no constituent corresponding to T. We therefore choose to index this role with the utterance of the whole sentence, *utt*. We will show how such indexing is useful when we look at the grammar rules below. It makes intuitive sense to do things this way, as we can readily think of the eventuality time being provided not by a particular constituent but by the sentence as a whole.[12] The role corresponding to S is thrice-indexed: by the grammatical function ev[13], by a constituent utterance and by the utterance *utt* of the whole sentence. We will find this indexing with *utt* useful when we come to the rule for PART-OF 'then', which requires the role for

[12]We are dealing with simple sentences here, where it is assumed that only one eventuality time is involved. In a bigger fragment, more complex sentences might well introduce more than one eventuality and eventuality time. Thus what we refer to here as a 'sentence' would be better described as a 'clause'.

[13]Actually it is perhaps not quite right to think of ev as a grammatical function, but we use it for consistency and for want of a better term. If preferred, a term such as 'sat-pred' (saturated predicate) could be used.

the previous eventuality in the discourse to be identified.

The information supported by the various constituent utterances, u_1, u_2, etc., is given in the form of feature structures as in STG. The notation:

$$u \models \begin{bmatrix} \text{use-of: 'liked'} \end{bmatrix}$$

for example, is shorthand for:

$u \models \langle\langle \text{use-of}, u, \text{'liked'} \rangle\rangle$.

The use of feature structures means that the feature is functional (single-valued).

In DSTG we also allow some features to take values which are sets. This is denoted by feat:{val}, for example:

$$u_4 \models \begin{bmatrix} \text{cat: } \{\text{np}\} \end{bmatrix}$$

This means that the 'cat' feature of u_4 is multivalued, and the above expression signifies that 'np' is among the values that it takes. This is useful because we want to regard the utterance of a proper-name such as 'Daniel' as being the same situation as the utterance of the corresponding NP. We can then say that the 'cat' value of this utterance is {n,np}. The notation:

$$u_4 \models \begin{bmatrix} \text{cat: } \{\ldots,\text{np}\} \end{bmatrix}$$

signifies that 'np' is the highest[14] category value in the set of category values for u_4 at this stage in the parse. In this case, for example, u_4 might support

$$\begin{bmatrix} \text{cat: } \{\text{n,np}\} \end{bmatrix}.$$

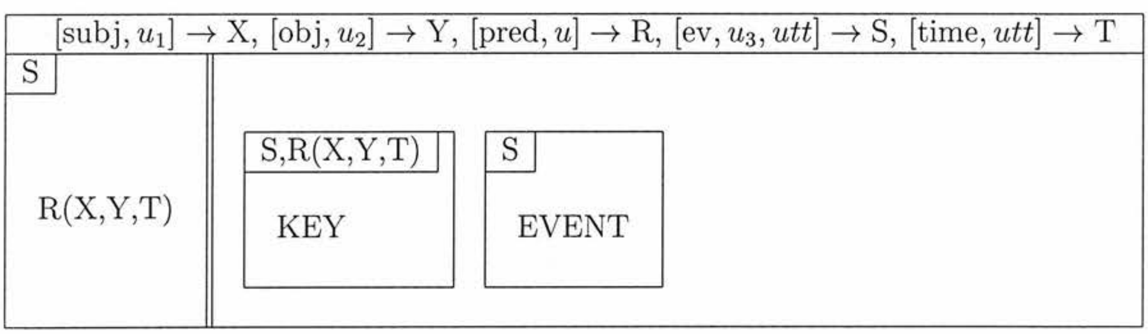
It should be noted that in all these rules there is implicit universal quantification over all variables on the left hand side, and implicit existential quantification over any new variables introduced on the right hand side (i.e., after the 'if'). The rules are essentially presented in Horn clause format.

[14]That is, the highest in the parse tree, where s′ is at the top.

Finally, a note about *in* and *out*. In a lexical entry for a verb, such as the one above, the discourse referents corresponding to parameters S and T are added to *in*. Note that the time role is added even though this does not correspond to an explicit temporal referent. It is perhaps not quite right to think of this role as a referent, but nevertheless it is useful to add it here for bookkeeping purposes. When we discuss the rules for temporal adverbials below, we will show how explicit temporal referents are distinguished from eventuality times in *in* and *out*. The referents corresponding to the subject and object roles are not introduced by the verb but by the subject and object constituents (see the lexical entries for proper names, below). The fact that set union, ∪, is used to add new referents to *in* means that if a referent is already a member of *in* it will not be added again.

We will now give the lexical entry for 'climbed'. It is very similar to the one for 'liked', the only important difference being that in this case the described situation is of type EVENT.

climbed:
(u, utt, ty, f, in, out):v
where *ty* is:



if:

$[[\text{pred},u] \rightarrow \text{climb}] \subseteq f$

$$u \models \begin{bmatrix} \text{use-of:} & \text{`climbed'} \\ \text{cat:} & \{\text{v}\} \\ \text{trans:} & \text{pos} \\ \text{aspect:} & \text{simple} \\ \text{time-ref:} & \text{past} \end{bmatrix}$$

$$u_1 \models \begin{bmatrix} \text{cat:} & \{\ldots,\text{np}\} \end{bmatrix}$$

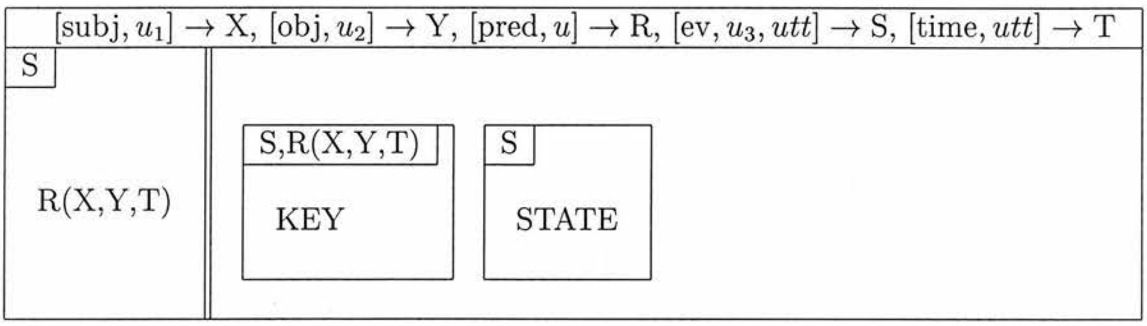
$$u_2 \models \begin{bmatrix} \text{cat:} & \{\ldots,\text{np}\} \end{bmatrix}$$

$$u_3 \models \begin{bmatrix} \text{ev-type:} & \text{event} \end{bmatrix}$$

$out = in \cup \{[\text{ev},u_3,utt], [\text{time},utt]\}$.

The lexical entry for the present participle 'climbing' is as follows:

climbing:
(u, utt, ty, f, in, out):v
where ty is:



if:

$[[\text{pred},u] \rightarrow \text{climbing}] \subseteq f$

$$u \models \begin{bmatrix} \text{use-of:} & \text{`climbing'} \\ \text{cat:} & \{\text{v}\} \\ \text{trans:} & \text{pos} \\ \text{aspect:} & \text{prog} \end{bmatrix}$$

$$u_1 \models \begin{bmatrix} \text{cat:} & \{\ldots,\text{np}\} \end{bmatrix}$$

$$u_2 \models \begin{bmatrix} \text{cat:} & \{\ldots,\text{np}\} \end{bmatrix}$$

$$u_3 \models \begin{bmatrix} \text{ev-type:} & \text{state} \end{bmatrix}$$

$out = in \cup \{[\text{ev},u_3,utt], [\text{time},utt]\}$.

In this fragment we treat progressives as stative: thus S is of type STATE. We also use the relation 'climbing', but we leave the relationship between 'climb' and 'climbing' unanalysed here. We are aware that this is a rather perfunctory and unsatisfactory treatment of the progressive, but analysing the progressive is not a chief aim of this fragment. We give a detailed analysis of the progressive in (Glasbey 1994a).

Our DSTG fragment also includes the intransitive 'ran' and 'running'. In these cases, ty contains the infon run(X,T). Otherwise the entries are essentially the same as for 'climb' and 'climbing'. We will not be concerned here with the differences between activities and accomplishments. Aspectual class distinctions such as these will be dealt with in Chapter 5.

ran:
(u, utt, ty, f, in, out):v
where ty is:

<table>
<tr><td colspan="2">$[\text{subj}, u_1] \rightarrow \text{X}$, $[\text{pred}, u] \rightarrow \text{R}$, $[\text{ev}, u_2, utt] \rightarrow \text{S}$, $[\text{time}, utt] \rightarrow \text{T}$</td></tr>
<tr><td>S

R(X,T)</td><td><table><tr><td>S,R(X,T)

KEY</td><td>S

EVENT</td></tr></table></td></tr>
</table>

if:

$[[\text{pred},u] \rightarrow \text{run}] \subseteq f$

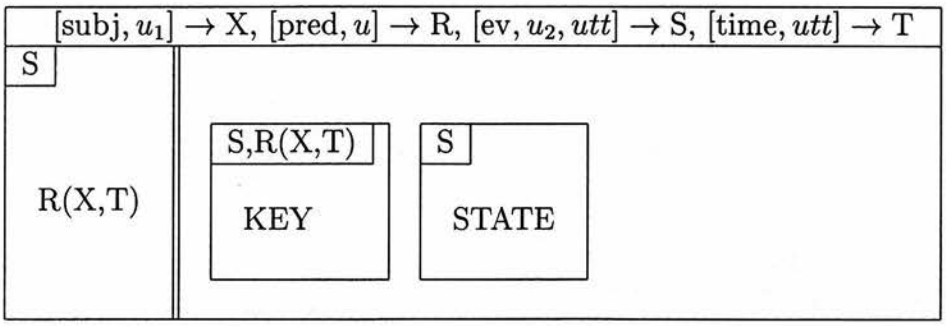
$$u \models \begin{bmatrix} \text{use-of:} & \text{`ran'} \\ \text{cat:} & \{\text{v}\} \\ \text{trans:} & \text{neg} \\ \text{aspect:} & \text{simple} \\ \text{time-ref:} & \text{past} \end{bmatrix}$$

$$u_1 \models \begin{bmatrix} \text{cat:} & \{\ldots,\text{np}\} \end{bmatrix}$$

$$u_2 \models \begin{bmatrix} \text{ev-type:} & \text{event} \end{bmatrix}$$

$out = in \cup \{[\text{ev},u_2,utt], [\text{time},utt]\}$.

running:
(u, utt, ty, f, in, out):v
where ty is:



if:

$[[\text{pred},u] \rightarrow \text{running}] \subseteq f$

$$u \models \begin{bmatrix} \text{use-of:} & \text{`running'} \\ \text{cat:} & \{\text{v}\} \\ \text{trans:} & \text{neg} \\ \text{aspect:} & \text{prog} \end{bmatrix}$$

$$u_1 \models \begin{bmatrix} \text{cat:} & \{\ldots,\text{np}\} \end{bmatrix}$$

$$u_2 \models \begin{bmatrix} \text{ev-type:} & \text{state} \end{bmatrix}$$

$out = in \cup \{[\text{ev},u_2,utt], [\text{time},utt]\}$.

We will now consider lexical entries for proper names, including temporal ones like 'July' and non-temporal ones like 'Daniel'. The lexical entry for 'Daniel' is:

'Daniel':
(u, utt, ty, f, in, out):n
where ty is:

$[gf,u] \to \mathrm{X}$, $[\mathrm{time}, utt] \to \mathrm{T}$, $[\mathrm{ev}, u_1, utt] \to \mathrm{S}$, $[\mathrm{bg}, u] \to \mathrm{B}$, $[\mathrm{res}, u] \to \mathrm{Rs}$	
S $\sigma(\mathrm{X}, \mathrm{T})$	S,σ(X, T) KEY Rs named(X,'Daniel') B male(X)

if:

$$u \models \begin{bmatrix} \text{use-of:} & \text{`Daniel'} \\ \text{cat:} & \{\text{n}\} \\ \text{person:} & \text{third} \\ \text{noun-class:} & \text{proper} \\ \text{noun-type:} & \text{nominal} \\ \text{gf:} & gf \end{bmatrix}$$

$out = in \cup \{[gf,u]\}$.

Note that the grammatical function for the role corresponding to X is a variable, gf. This is because 'Daniel' may be used as either the subject or object of a sentence. It is thus necessary to leave the gramatical function unspecified in the lexical entry. When constituent combination occurs according to one of the rules of the grammar, gr will become instantiated to either 'subj' or 'obj', as appropriate.

Observe, too, that the roles corresponding to the background situation B and the resource situation Rs are indexed with the utterance u. It is necessary to identify resource and background situations with constituent utterances in this way for the following reason. We sometimes need more than one resource situation for an utterance of a single sentence, because of cases like:

(3.23) The dog chased the dog

where a separate resource situation is needed for each utterance of 'the dog' in order to identify a unique referent in each case. Such examples are discussed in (Cooper 1993a).

The lexical entries for 'Owen', 'Emily' and so on are very similar to the one for 'Daniel'. The entries for 'Ben Nevis' and 'Snowdon' differ slightly in that of course there is no gender specification here. We give the entry for 'Ben Nevis' below.

'Ben Nevis':
(u, utt, ty, f, in, out):n
where ty is:

<table>
<tr><td colspan="2">$[gf, u] \to \mathrm{X}$, $[\mathrm{time}, utt] \to \mathrm{T}$, $[\mathrm{ev}, u_1, utt] \to \mathrm{S}$, $[\mathrm{res}, u] \to \mathrm{Rs}$</td></tr>
<tr><td>S

$\sigma(\mathrm{X}, \mathrm{T})$</td><td>S,$\sigma(\mathrm{X}, \mathrm{T})$
KEY

Rs
named(X,'Ben Nevis')</td></tr>
</table>

if:

$$u \models \begin{bmatrix} \text{use-of:} & \text{`Ben Nevis'} \\ \text{cat:} & \{\text{n}\} \\ \text{person:} & \text{third} \\ \text{noun-class:} & \text{proper} \\ \text{noun-type:} & \text{nominal} \\ \text{gf:} & gf \end{bmatrix}$$

$out = in \cup \{[gf, u]\}$.

In this fragment, the only type of nouns are proper nouns and temporal proper nouns. For the temporal noun 'July' we have the following lexical entry:

'July':
(u, utt, ty, f, in, out):n
where ty is:

$[\text{time}, utt] \rightarrow \text{T}, [\text{ev}, u_1, utt] \rightarrow \text{S}, [\text{res}, u] \rightarrow \text{Rs}, [\text{etr}, u, utt] \rightarrow \text{T}'$

S	S,σ(T)	Rs
σ(T)	KEY	named(T$'$,'July')

if:

$$u \models \begin{bmatrix} \text{use-of:} & \text{'July'} \\ \text{cat:} & \{\text{n}\} \\ \text{person:} & \text{third} \\ \text{noun-class:} & \text{proper} \\ \text{noun-type:} & \text{temporal} \\ \text{adv-type:} & \text{frame} \\ \text{adv-class:} & \text{etr} \end{bmatrix}$$

$out = in \cup \{[\text{time},utt], [\text{etr},u,utt]\}$.

Here, an additional time parameter T$'$ has been introduced. This is because 'July' is an explicit temporal referent. The role corresponding to T$'$ is indexed with 'etr', the utterance of 'July' (u), and utt. This indexing with utt will be needed when we come to the rule for ETR 'then', which requires us to identify the ETR role most recently added to in.

The feature information supported by u conveys that u is of noun-type 'temporal' (as opposed to 'nominal'), that it is of adverbial-type 'frame' (meaning that it may combine with a preposition to give a frame adverbial like 'in July') and that it is an ETR use. This latter information will again be used in the rule for ETR 'then'.

The lexical entry for the auxiliary 'was' (required for the progressive) is given below. No updating of in takes place here, so we set out to equal in.

was:
(u, utt, ty, f, in, out):aux
where ty is:

$[\text{time}, utt] \rightarrow \text{T}$, $[\text{pred}, u_1] \rightarrow \text{R}$ $[\text{ev}, u_2, utt] \rightarrow \text{S}$, $[\text{subj}, u_3] \rightarrow \text{X}$

S	
$\sigma(\text{X}, \text{T})$	$\boxed{\text{S}, \sigma(\text{X}, \text{T})}$ KEY $\boxed{\text{S}}$ STATE

if:

$$u \models \begin{bmatrix} \text{use-of:} & \text{`was'} \\ \text{cat:} & \{\text{aux}\} \\ \text{time-ref:} & \text{past} \end{bmatrix}$$

$$u_3 \models \begin{bmatrix} \text{person:} & \text{third} \end{bmatrix}$$

$out = in.$

We now give the lexical entry for the preposition 'in'.

in:
(u, utt, ty, f, in, out):prep
where ty is:

$[\text{time}, utt] \rightarrow \text{T}$, $[\text{ev}, u_1, utt] \rightarrow \text{S}$, $[\text{etr}, u_2, utt] \rightarrow \text{T}'$, $[\text{bg}, u_2] \rightarrow \text{B}$

S	
$\sigma(\text{T})$	$\boxed{\text{S}, \sigma(\text{T})}$ KEY **if** S:EVENT **then** B $\models \text{T} \sqsubseteq \text{T}'$ **if** S:STATE **then** B $\models \text{T} \circ \text{T}'$

if:

$$u \models \begin{bmatrix} \text{use-of:} & \text{`in'} \\ \text{cat:} & \{\text{prep}\} \\ \text{prep-type:} & \text{frame} \end{bmatrix}$$

$out = in.$

Note that $\sqsubseteq$ denotes temporal inclusion and $\circ$ denotes temporal overlap.

Thus ty for 'in' introduces a parameter T′ corresponding to an explicit temporal referent (the ETR will be whatever 'in' combines with to form an AdvP — such as 'July').

u is of prep-type 'frame', signifying that it combines with another constituent (a temporal NP) to form a frame adverbial.

The information supported by B depends on whether S is of type EVENT or STATE. The appropriate information will be added to the restrictions of ty.

No referents are added to in.

We now come to the lexical entries for 'then'. These are based on the theoretical analysis of 'then' that we gave in Chapter 2, and therefore reflect the two readings for 'then' that we called ETR 'then' and PART-OF 'then'.

First, we give the entry for ETR 'then'. We showed in Chapter 2 how this reading of 'then' depends upon the presence in the discourse context of a temporal discourse referent corresponding to an **explicit temporal referent** (ETR) such as 'July' or 'Thursday' or '2pm'. ETR 'then' is anaphoric in the sense that it relates the time of the eventuality in the current utterance to this previously-introduced temporal referent. Thus, the rule for ETR 'then' must identify such a temporal referent — one that was introduced by an ETR earlier in the discourse. We make the simplifying assumption here that the rule for ETR 'then' finds the **most recently introduced** temporal referent of this kind. As discussed in Chapter 2, things may be more complicated than this, and we suspect that discourse structure may have a part to play here, in which case a full analysis would require a detailed theory of discourse structure. Here, we will simply allow the rule for ETR 'then' to seek out the most recently introduced temporal referent. If no such referent is available, the rule will fail.

We must be careful to distinguish between temporal referents that were introduced by explicit mention of a time (an ETR) and those which are inferred from the description of an eventuality. Recall that our lexical entries described above express this distinction. A time referent **not** introduced by an ETR is added to *in* in the form:

[time,*utt*]

whereas a time referent introduced by an ETR is added to *in* in the form:

[etr,*u*,*utt*]

In the latter case, the lexical entry also tell us that:

$$u \models \begin{bmatrix} \text{adv-class: etr} \end{bmatrix}$$

Note: This distinction is crucial in obtaining the correct readings for 'then'. It replaces the distinction made in Chapter 2 between event referents (introduced by all sentences) and time referents (introduced only by sentences with explicit temporal referents).

We will therefore require the rule for ETR 'then' to find from *in* the most recently added temporal referent of form [etr,*u*,*utt*], and to check that:

$$u \models \begin{bmatrix} \text{adv-class: etr} \end{bmatrix}$$

In order to find the most recent temporal referent, we will need to make sure that we can identify the most recent utterance. One way of doing this would be to mark each utterance situation with the time of utterance. Another would be to index each utterance with a natural number in ascending order. We will not attempt to spell out the details of this here, but assume that it is possible somehow to identify the most recently-uttered referent of the kind we want.

The rule for ETR 'then' therefore looks as follows:

ETR then:
(u, utt, ty, f, in, out):adv
where ty is:

$[\text{time}, utt] \rightarrow \text{T}$, $[\text{ev}, u_1, utt] \rightarrow \text{S}$, $[\text{etr}, u_2, utt'] \rightarrow \text{T}'$, $[\text{bg}, u] \rightarrow \text{B}$

S	
σ(T)	S,σ(T): KEY **if** S:EVENT **then** $\text{B} \models \text{T} \sqsubseteq \text{T}'$ **if** S:STATE **then** $\text{B} \models \text{T} \circ \text{T}'$

if:

$[\text{etr}, u_2, utt'] \in in$

where utt' is the most recent utterance containing an ETR

$$u \models \begin{bmatrix} \text{use-of:} & \text{`then'} \\ \text{cat:} & \{\text{adv}\} \\ \text{then-type:} & \text{etr} \\ \text{posn:} & \text{sf} \end{bmatrix}$$

$$u_2 \models \begin{bmatrix} \text{cat:} & \{\ldots,\text{np}\} \\ \text{noun-class:} & \text{proper} \\ \text{noun-type:} & \text{temporal} \\ \text{adv-type:} & \text{frame} \\ \text{adv-class:} & \text{etr} \end{bmatrix}$$

$out = in.$

As explained above, this rule identifies the most recent utterance of an ETR, from *in*. The background situation B for the utterance of 'then' is made to support information about how the parameter T′ corresponding to this ETR relates to the time T of the eventuality described by the current utterance. The exact nature of this information depends on whether the current eventuality S is an event or a state, just as in the lexical entry for 'in', above.

The requirement that u_2 supports the fact that the adverbial class is 'etr' checks that the identified referent was introduced by an ETR.[15]

Now let us look at the lexical entry for PART-OF 'then'.

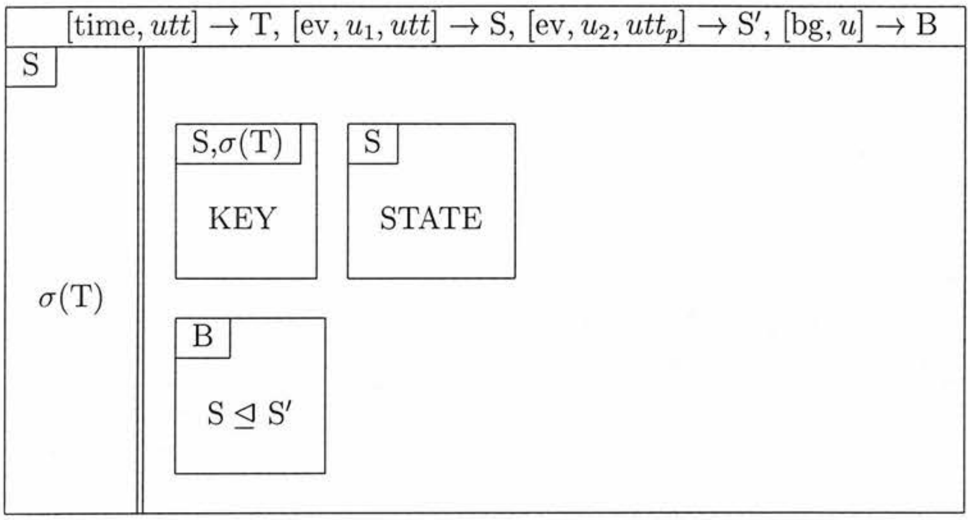
In Chapter 2 we showed how PART-OF 'then' conveys that the current eventuality is part of (using the informal notion PART-OF) the previous one. We showed that this may be the case if the discourse relation is **elaboration** or **backgrounding**. Testing for a possible elaboration depends on world knowledge, and we have not attempted to encode this in our fragment. There is no reason, however, why this could not be done. In this fragment we deal only with the backgrounding instance of PART-OF. We saw in Chapter 2 that the backgrounding relation requires that the current eventuality is stative (which, in this fragment, means that we have either a lexical stative or a progressive). The rule for PART-OF 'then' will therefore need to check that the current eventuality is a state. In the current fragment, we replace the informal PART-OF of Chapter 2 with the situation theoretic PART-OF relation $\trianglelefteq$ (see Section 3.2).

In this case, we will need to identify the previous utterance, utt_p. The background situation B is made to support the information that the current eventuality S is PART-OF the eventuality S′ described by the previous utterance.

The rule is as follows:

PART-OF then:
(u, utt, ty, f, in, out):adv
where ty is:

[15] Although, in fact, we are double-checking here because the form of the referent $[\text{etr}, u_2, utt']$ in in ensured that the referent was introduced by an ETR. It is possible that in a bigger fragment we might want to index the parameter by something more general than 'etr' — for example, if we had temporal adverbials that are not ETRs, such as 'for'-adverbials. The check that u_2 supports the fact that the adverbial class is 'etr' would then be required.



if:

$[\mathrm{ev}, u_2, utt_p] \in in$,
(where utt_p is the previous utterance)

$$u \models \begin{bmatrix} \text{use-of:} & \text{`then'} \\ \text{cat:} & \{\text{adv}\} \\ \text{then-type:} & \text{pt-of} \\ \text{posn:} & \text{sf} \end{bmatrix}$$

$$u_1 \models \begin{bmatrix} \text{ev-type:} & \text{state} \end{bmatrix}$$

$out = in.$

If there is no previous eventuality (i.e., if the current eventuality is the first in the discourse), or if the current eventuality is not a state, the rule for PART-OF 'then' will fail. This allows us to rule out unacceptable sequences of the kind discussed in Chapter 2. We will give some examples of the rules for 'then' in action in the next section.

Now let us look at the lexical entry for sentence-initial 'then'. We saw in Chapter 2 that sentence-initial 'then' conveys that the current eventuality is temporally preceded by the previously-described eventuality. There were no requirements here on whether the current eventuality is an event or a state. The lexical entry is therefore comparatively straightforward. It requires the time of the previous eventuality to be identified, and makes B support the information that T′ temporally precedes T.

The lexical entry is as follows:

SI then:
(u, utt, ty, f, in, out):adv
where ty is:

$$\begin{array}{|l||l|}\hline \multicolumn{2}{|c|}{[\text{time}, utt] \to \text{T},\ [\text{ev}, u_1, utt] \to \text{S},\ [\text{time}, utt_p] \to \text{T}',\ [\text{bg}, u] \to \text{B}} \\ \hline \boxed{\text{S}} & \\ \sigma(\text{T}) & \begin{array}{|c|}\hline \text{S},\sigma(\text{T}) \\ \hline \text{KEY} \\ \hline \end{array} \quad \begin{array}{|c|}\hline \text{B} \\ \hline \text{T}' \prec \text{T} \\ \hline \end{array} \\ \hline \end{array}$$

if:

$[\text{time}, utt_p] \in in$,
where utt_p is the previous utterance

$$u \models \begin{bmatrix} \text{use-of:} & \text{`then'} \\ \text{cat:} & \{\text{adv}\} \\ \text{then-type:} & \text{si} \\ \text{posn:} & \text{init} \end{bmatrix}$$

$out = in \cup \{[\text{time},utt]\}$.

This completes the set of lexical entries for our fragment. We will now move on to look at the grammar rules for constituent combination, which are of a similar form to the lexical entries.

We precede each rule with its number and an abbreviated form of the rule to show its essential structure (in bold type).

G1. NP $\to$ N
(u, utt, ty, f, in, out):np

if:

$u : [_{\text{np}}\ \text{n}]$

(u, utt, ty, f, in, out):n

$$u \models \begin{bmatrix} \text{cat:} & \{\text{n,np}\} \\ \text{noun-class:} & \text{proper} \end{bmatrix}.$$

Rule G1 says that a 6-tuple is of type np provided that the same 6-tuple is of type n and various other conditions hold. The notation;

$u : [_{\text{np}}\ \text{n}]$

means that u is an utterance of a noun phrase and also an utterance of a noun, where np dominates n in the phrase structure tree. It seems intuitively correct to say that an utterance of, say, 'Emily' is an utterance of both a noun and a noun-phrase, rather than to require separate utterance situations for the n and the np. Of course, this rule only applies if the noun is a proper noun, and so we require this information to be supported by u. G1 applies to both nominal and temporal proper nouns.

The following rule is of similar form:

G2. AdvP $\to$ Adv
(u, utt, ty, f, in, out):advp

if:

$u : [_{\text{advp}}\ \text{adv}]$

(u, utt, ty, f, in, out):adv

$$u \models \begin{bmatrix} \text{use-of:} & \text{`then'} \\ \text{cat:} & \{\text{adv,advp}\} \\ \text{then-type:} & \text{init OR etr OR pt-of} \\ \text{posn:} & \text{si OR sf} \end{bmatrix}.$$

Now we come to a binary branching rule. Here, things are slightly different in that the constituent (daughter) uses are not the same situation as the combined (mother) use. Also, we have different types (ty_1 and ty_2) corresponding to the two constituents. We have departed from STG here. In STG, the infons for the two combining constituents are denoted by the same variable, and information is combined by unification. We cannot proceed this way here, as we no longer have simple infons with no restrictions as we had in STG. Instead, we have more complex types with restrictions, so unification would not be possible. Thus we require a way of "combining" the types of the daughter constitents to give the type for the mother constituent. We achieve this by using $\oplus$. This operation ensures that any roles which have the same set of indices will be assigned to the same parameter in the mother type. We also require that partially-specified infons denoted by $\sigma(T)$, $\sigma(X,T)$, etc. will be unified with a fully-specified infon such as run(X,Y,T). We will assume such unification in the following rules.

G3. AdvP → Prep, NP
(u, utt, ty, f, in, out):advp

if:

$u : [_{\text{advp}}\ \text{prep np}]$

$(u_1, utt, ty_1, f_1, in, mid)$:prep

$$u_1 \models \begin{bmatrix} \text{cat:} & \{\text{prep}\} \\ \text{prep-type:} & \text{frame} \end{bmatrix}$$

$(u_2, utt, ty_2, f_2, mid, out)$:np

$$u_2 \models \begin{bmatrix} \text{cat:} & \{\ldots,\text{np}\} \\ \text{noun-type:} & \text{temporal} \\ \text{adv-type:} & \text{frame} \end{bmatrix}$$

$$u \models \begin{bmatrix} \text{cat:} & \{\text{advp}\} \\ \text{noun-type:} & \text{temporal} \\ \text{adv-type:} & \text{frame} \\ \text{adv-class:} & \text{etr} \end{bmatrix}$$

$ty = ty_1 \oplus ty_2$

$f_1 \cup f_2 \subseteq f$.

We should explain the notation $u : [_{\text{advp}}\ \text{prep np}]$ in the above rule. This is intended to convey that u is of category 'advp' and has constituents u_1, u_2 of categories 'prep' and 'np' respectively, where u_1 precedes u_2. In general, if:

$u : [_{\text{x}}\ \text{y z}]$

then:

$$u \models \begin{bmatrix} \text{cat:} & \{\text{x}\} \\ \text{constituents:} & u_1, u_2 \\ \text{precedes:} & u_1, u_2 \end{bmatrix}$$

where $u_1 \models \begin{bmatrix} \text{cat:} & \{\text{y}\} \end{bmatrix}$

and $u_2 \models \begin{bmatrix} \text{cat:} & \{\text{z}\} \end{bmatrix}$

We will adopt this notational convention in all the rules that follow.

The rule also specifies that the union of the assignments f_1 and f_2 for the daughters is a subset of the assignment f for the mother.

The following unary branching rule for intransitives is straightforward:

G4. VP → V(intrans)
(u, utt, ty, f, in, out):vp

if:

$u : [_{\text{vp}}\ \text{v}]$

(u, utt, ty, f, in, out):v

$$u \models \begin{bmatrix} \text{cat:} & \{\text{v,vp}\} \\ \text{trans:} & \text{neg} \end{bmatrix}.$$

The corresponding rule for transitive verbs is:

G5. VP → V(trans), NP
(u, utt, ty, f, in, out):vp

if:

$u : [_{\text{vbar}}\ \text{v np}]$

$(u_1, utt, ty_1, f_1, in, mid)$:v

$$u_1 \models \begin{bmatrix} \text{cat:} & \{\text{v}\} \\ \text{trans:} & \text{pos} \\ \text{aspect:} & a \end{bmatrix}$$

$(u_2, utt, ty_2, f_2, mid, out)$:np

$$u_2 \models \begin{bmatrix} \text{cat:} & \{\ldots,\text{np}\} \\ \text{case:} & \text{acc} \\ \text{gf:} & \text{obj} \end{bmatrix}$$

$$u \models \begin{bmatrix} \text{cat:} & \{\text{vp}\} \\ \text{trans:} & \text{pos} \\ \text{aspect:} & \text{a} \end{bmatrix}$$

$ty = ty_1 \oplus ty_2$

$f_1 \cup f_2 \subseteq f$.

In this rule, instantiation of the grammatical function, gf for the NP takes place — gf is given the value 'obj'.

The following rule is for progressives.

G6. VP $\rightarrow$ Aux, VP
(u, utt, ty, f, in, out):vp

if:

$u : [_{\text{vp}}\ \text{aux vp}]$

$(u_1, utt, ty_1, f_1, in, mid)$:aux

$$u_1 \models \begin{bmatrix} \text{cat:} & \{\text{aux}\} \\ \text{time-ref:} & tr \end{bmatrix}$$

$(u_2, utt, ty_2, f_2, mid, out)$:vp

$$u_2 \models \begin{bmatrix} \text{cat:} & \{\ldots,\text{vp}\} \\ \text{aspect:} & \text{prog} \end{bmatrix}$$

$$u \models \begin{bmatrix} \text{cat:} & \{\text{vp}\} \\ \text{aspect:} & \text{prog} \\ \text{time-ref:} & tr \end{bmatrix}$$

$ty = ty_1 \oplus ty_2$

$f_1 \cup f_2 \subseteq f.$

The next rule, as we explained earlier, is introduced in order to allow expansion of the fragment to include modals.

G7. VP′ → VP
(u, utt, ty, f, in, out):vp′

if:

$u : [_{\text{vp}'}\ \text{vp}]$

(u, utt, ty, f, in, out):vp

$$u \models \begin{bmatrix} \text{cat:} & \{\ldots,\text{vp},\text{vp}'\} \end{bmatrix} .$$

We now give the s-rule. In this rule, the grammatical function, gf for the NP is instantiated to 'subj'.

G8. S → NP, VP′
(u, utt, ty, f, in, out):s

if:

$u : [_{\text{s}}\ \text{np vp}']$

$(u_1, utt, ty_1, f_1, in, mid)$:np

$$u_1 \models \begin{bmatrix} \text{cat:} & \{\ldots,\text{np}\} \\ \text{case:} & \text{nom} \\ \text{gf:} & \text{subj} \end{bmatrix}$$

$(u_2, utt, ty_2, f_2, mid, out)$:vp′

$ty = ty_1 \oplus ty_2$

$f_1 \cup f_2 \subseteq f.$

We now come to the S′ rules. The first of these corresponds to a sentence with no adverbial (recall that all adverbials are sentence-level in this fragment).

G9. S′ → S
$(utt, utt, ty, f, in, out)$:sbar

if:

$utt : [_{s'}\ s]$

$(utt, utt, ty, f, in, out)$:s

$utt \models \left[\text{cat: } \{\ldots,\text{s,sbar}\}\right]$.

Note that the first two arguments are identical here. This is because we have reached the top of the tree and the utterance situation for the utterance as a whole is the same as that for S′.

After S′ has been parsed, the overall DRS for the discourse so far is updated with the type *ty* obtained from the parsing of S′. We explained earlier that the DRS/type for a discourse consisting of a sequence of utterances is the type obtained by combining with ⊕ the type from each utterance. This means that we "update" the overall DRS, which we will call *odrs_new*, by combining *ty* obtained from parsing S′ with the DRS for the previous discourse. Thus:

$odrs\_new = odrs\_old \oplus ty$

Notice that in DSTG we can no longer deal with anaphora in the same way as in STDRT. In STDRT, anaphora was captured by role-indexing. When the types are combined and new parameters are assigned by ⊕, roles that have the same indices are assigned to the same parameter. We will see this working in a number of examples in Chapter 4. However, in DSTG we have indexed some of the roles with utterance situations. Because the utterance situations will be different, the set of role indices for the anaphor and its potential referent will be different too, and therefore a common parameter will not be assigned. We could get around this by redefining ⊕ so that it "ignores" utterance indexing. Note, however, that we have also indexed the roles with their grammatical functions or something similar. This would mean that an anaphor indexed as "subject" would not be identified with a referent whose grammatical function was "object". In order to get around this, ⊕ would have to ignore indexing by grammatical function, too.

Rather than introduce all these complications, it is simpler to find an alternative way to deal with anaphora. Instead of capturing anaphora by having $\oplus$ assign the same parameter to anaphor and referent, we will allow $\oplus$ to assign different parameters, but will introduce a restriction that sets the two relevant parameters to be equal.

The above remarks apply to both nominal and temporal anaphora, although we have no nominal anaphora in this fragment. In fact, this is the way that we have been doing temporal anaphora with ETR 'then' in DSTG. We have been introducing restrictions like:

B

$$\mathrm{T} \sqsubseteq \mathrm{T}'$$

which express the relation between parameters. We are suggesting that pronominal anaphora can be done the same way. In this case the restriction would be:

B

$$\mathrm{X} = \mathrm{Y}$$

We also need S′ rules for combining s with sentence-initial and sentence-final adverbials. In this fragment, the only sentence-initial adverbial is 'then'. Sentence-final adverbials include 'then' and 'in July'.

We give the rule for sentence-final adverbials first:

G10. S′ → S, AdvP
(u, utt, ty, f, in, out):s′

if:

$u : [_{\mathrm{s}'}\ \mathrm{s\ advp}]$

$(u_1, utt, ty_1, f_1, in, mid)$:s

$u_1 \models \left[\mathrm{cat:}\ \ \{\ldots,\mathrm{s}\}\right]$

$(u_2, utt, ty_2, f_2, mid, out)$:advp

$$u_2 \models \begin{bmatrix} \text{cat:} & \{\ldots,\text{advp}\} \\ \text{posn:} & \text{sf} \end{bmatrix}$$

$ty = ty_1 \oplus ty_2$

$f_1 \cup f_2 \subseteq f$.

Once again, updating of the discourse DRS is carried out by means of $\oplus$ — i.e.:

$odrs\_new = odrs\_old \oplus ty$

And now the rule for sentence-initial adverbials:

G11. S$'$ $\rightarrow$ AdvP, S
(u, utt, ty, f, in, out):s$'$

if:

$u : [_{\text{s}'}\ \text{advp s}]$

$(u_1, utt, ty_1, f_1, in, mid)$:advp

$$u_1 \models \begin{bmatrix} \text{cat:} & \{\ldots,\text{advp}\} \\ \text{posn:} & \text{si} \end{bmatrix}$$

$(u_2, utt, ty_2, f_2, mid, out)$:s

$$u_2 \models \begin{bmatrix} \text{cat:} & \{\ldots,\text{s}\} \end{bmatrix}$$

$ty = ty_1 \oplus ty_2$

$f_1 \cup f_2 \subseteq f$.

And, once again:

$odrs\_new = odrs\_old \oplus ty$

Finally, we need some discourse rules. We need to thread the sets *in* and *out* of discourse referents through the discourse. There is no need, however, for the assignment f for a particular utterance to be threaded to the next utterance. The type *ty* does not need to be threaded either, as, after an utterance has been parsed, *ty* is combined by means of $\oplus$ with the DRS for the whole discourse so far (see above). Thus 'dis' in the rules below need only be a ternary and not a 6-ary type.

G12. Dis → S′
$(disc, in, out)$:dis

if:

$disc$: $[_{\text{dis}}\ \text{s}']$

$(disc, disc, ty, f, in, out)$:s′

$disc \models \begin{bmatrix}\text{cat: } \{\ldots,\text{s}',\text{dis}\}\end{bmatrix}$.

G13. Dis → S′, Dis
$(disc, in, out)$:dis

if:

$disc$: $[_{\text{dis}}\ \text{s}'\ \text{dis}]$

$(u_1, u_1, ty, f, in, mid)$:s′

$u_1 \models \begin{bmatrix}\text{cat: } \{\ldots,\text{s}'\}\end{bmatrix}$

(u_2, mid, out):dis.

This concludes the grammar rules. In the next section, we will look at some examples.

3.7 Processing of Sentence-Final 'then' by the Grammar Rules

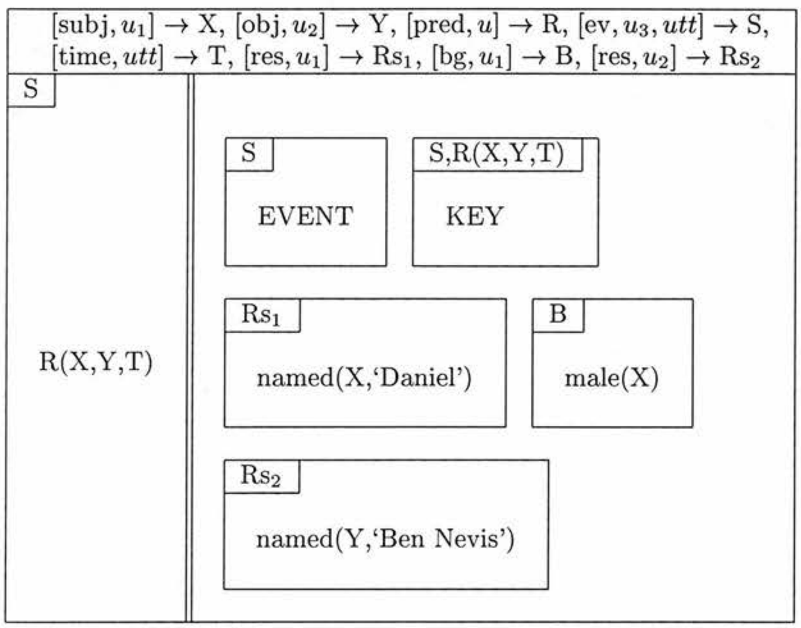
We will now show how the grammar rules give the required readings for discourses containing sentence-final 'then'.

We have already seen that the processing of an utterance of a sentence according to the grammar constructs a type corresponding to the sentence meaning. At the end of processing an utterance, the type for that sentence is added by means of $\oplus$ to the overall DRS/type obtained from processing the discourse so far.

For example, the DRS/type obtained from processing the single-sentence discourse:

(3.24) Daniel climbed Ben Nevis

is shown below in {1}.



{1}

The result of parsing (3.24) will also include the information:

[[pred,u] → climb] ⊆ f.

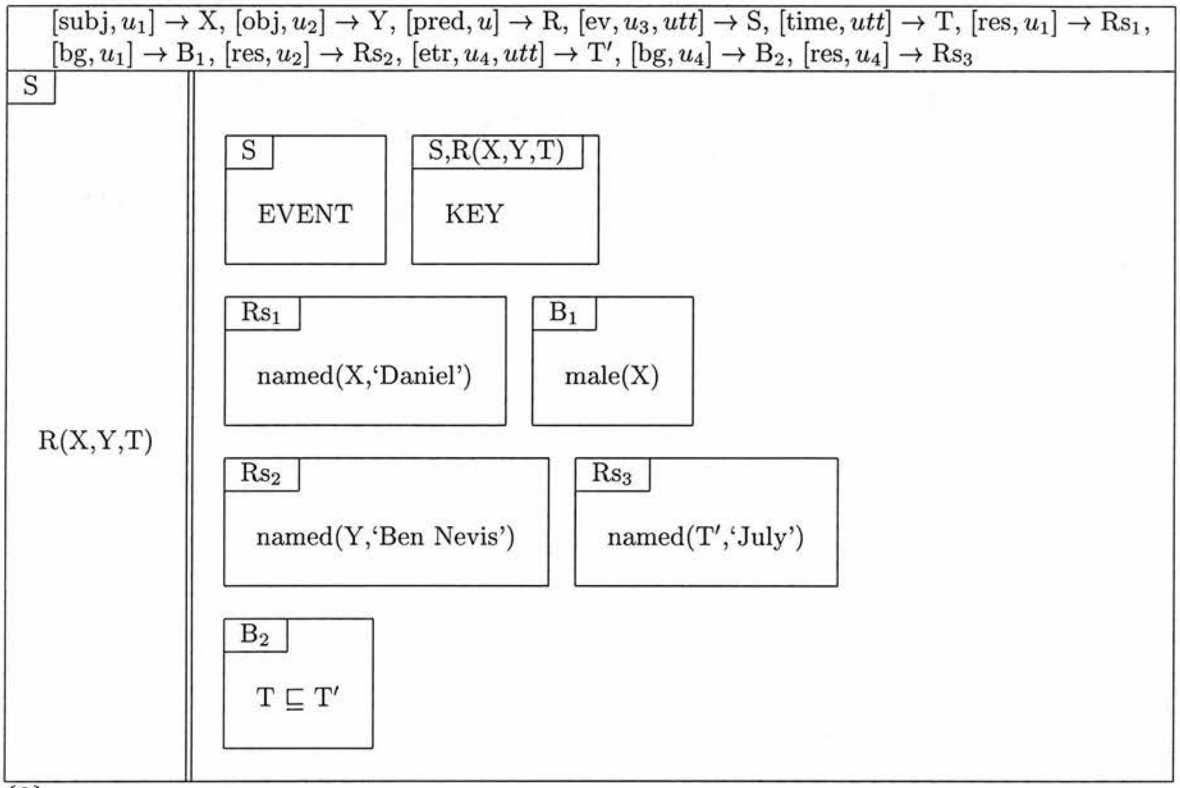
The processing of (3.24) gives rise too to syntactic information supported by the utterance situations corresponding to the various constituents, but we do not include that information here. Also, as described in the previous section, a list of discourse referents is built up as the discourse is processed, and passed from NP to VP′ within an individual sentence and from one sentence to the next in the discourse. The value of *out* after processing the single-sentence discourse (3.24) is:

{[subj,u_1], [obj,u_2], [ev,u_3,utt], [time,utt]}

Now compare {1} with the DRS/type obtained from processing the single-sentence discourse:

(3.25) Daniel climbed Ben Nevis in July

shown in $\{2\}$ below:



$\{2\}$

where:

$[[\text{pred},u] \rightarrow \text{climb}] \subseteq f$

and:

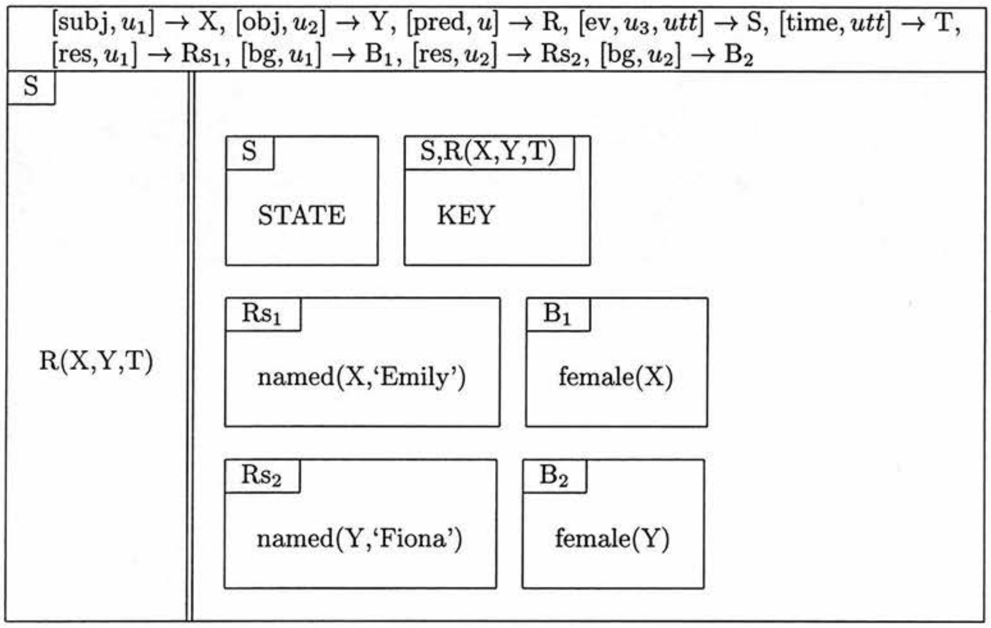
$out = \{[\text{subj},u_1], [\text{obj},u_2], [\text{ev},u_3,utt], [\text{time},utt], [\text{etr},u_4,utt]\}$

In $\{2\}$, we have a second temporal parameter T′, corresponding to the explicit temporal referent 'July'. The role obtained by abstracting over T′ is indexed 'etr', indicating that it was introduced by an explicit temporal referent.

Now let us look at the representation obtained by processing the single-sentence discourse:

(3.26) Emily liked Fiona

In this case, we get the DRS/type shown in {3}.



{3}

where:

$[[\text{pred},u] \rightarrow \text{like}] \subseteq f$

and:

$out = \{[\text{subj},u_1], [\text{obj},u_2], [\text{ev},u_3,utt], [\text{time},utt]\}$

And for:

(3.27) Owen was climbing Snowdon

we get the DRS/type shown in {4}:

[subj, u_1] → X, [obj, u_2] → Y, [pred, u] → R, [ev, u_3, *utt*] → S, [time, *utt*] → T, [res, u_1] → Rs_1, [bg, u_1] → B, [res, u_2] → Rs_2

S	
R(X,Y,T)	S: STATE; S,R(X,Y,T): KEY; Rs_1: named(X,'Owen'); B: male(X); Rs_2: named(Y,'Snowdon')

{4}

where:

[[pred,u] → climbing] ⊆ f

and:

out = {[subj,u_1], [obj,u_2], [ev,u_3,*utt*], [time,*utt*]}

This contains the information that S is STATE, because we treat progressives as stative in this fragment.

Now let us consider the representations for some discourse sequences involving 'then'. Consider first:

(3.28) a. Daniel climbed Ben Nevis in July
b. Owen climbed Snowdon then

After processing (3.28a) the discourse DRS is {2}, and the value of *out* (which, of course, is *in* for processing (3.28b)) is:

{[subj,u_1], [obj,u_2], [ev,u_3,*utt*], [time,*utt*], [etr,u_4,*utt*]}

(3.28b) is processed as far as 'then'. At S level, the type is similar to {1}, shown in {5}:

$[\text{subj}, u_5] \rightarrow$ X, $[\text{obj}, u_6] \rightarrow$ Y, $[\text{pred}, u_7] \rightarrow$ R, $[\text{ev}, u_8, utt_2] \rightarrow$ S,
$[\text{time}, utt_2] \rightarrow$ T, $[\text{res}, u_5] \rightarrow \text{Rs}_1$, $[\text{bg}, u_5] \rightarrow$ B, $[\text{res}, u_6] \rightarrow \text{Rs}_2$

S	
R(X,Y,T)	S: EVENT; S,R(X,Y,T): KEY; Rs_1: named(X,'Owen'); B: male(X); Rs_2: named(Y,'Snowdon')

{5}

where:

$[[\text{pred},u_7] \rightarrow \text{climb}] \subseteq f$

Now we come to the

$\text{S}' \rightarrow \text{S, AdvP}$

rule. We need to parse 'then' as an AdvP. In order to do this, we must first parse 'then' as an Adv. There are two rules in the grammar for sentence-final 'then': one for ETR 'then' and one for PART-OF 'then'. These are tried in turn. If both succeed, (3.28a,3.28b) will have two readings, in accordance with the ambiguity we observed for some sequences with 'then'. If both rules fail, the whole parse will fail and no representation for the discourse will be obtained.[16]

First, let us consider the rule for ETR 'then'. This requires that $[\text{etr},u,utt'] \in in$.

That is, *in* must contain a referent indexed $[\text{etr},u,utt']$, where utt' is a previous utterance. If more than one such referent is available, the most recently introduced one is chosen, as discussed in Section 3.6.4.

Looking at *in* (which, of course, is *out* for (3.28a)), we see that such a referent is

[16] An alternative would be to allow the sequence to be parsed but to indicate in some way that no referent has been found for 'then'. We consider this to be a reasonable alternative but have nevertheless chosen the first option.

indeed present, i.e.:

[etr,u_4,utt']

Thus the rule for ETR 'then' succeeds, giving the DRS/type {6} for the utterance of the adverb 'then':

<table>
<tr><td colspan="2">[time, utt_2] → T, [ev, u_8, utt_2] → S, [bg, u_9] → B, [etr, u_4, utt] → T′</td></tr>
<tr><td>S

σ(T)</td><td><table><tr><td>S,R(X,Y,T)

KEY</td><td>B

T ⊑ T′</td></tr></table></td></tr>
</table>

{6}

When {6} is combined by means of ⊕ with the type {5} for the S parse, we get the type {7} for S′:

<table>
<tr><td colspan="2">[subj, u_5] → X, [obj, u_6] → Y, [pred, u_7] → R, [ev, u_8, utt_2] → S, [time, utt_2] → T,
[res, u_5] → Rs_1, [bg, u_5] → B, [res, u_6] → Rs_2, [bg, u_9] → B_1, [etr, u_4, utt] → T′</td></tr>
<tr><td>S

R(X,Y,T)</td><td><table><tr><td>S

EVENT</td><td>S,R(X,Y,T)

KEY</td></tr><tr><td>Rs_1

named(X,'Owen')</td><td>B

male(X)</td></tr><tr><td>Rs_2

named(Y,'Snowdon')</td><td>B

T ⊑ T′</td></tr></table></td></tr>
</table>

{7}

Now if we combine {2} with {7} using ⊕ we get the overall DRS/type for (3.28a,3.28b), {8}:

$[\mathrm{subj}, u_1] \rightarrow \mathrm{X}_1$, $[\mathrm{obj}, u_2] \rightarrow \mathrm{Y}_1$, $[\mathrm{pred}, u] \rightarrow \mathrm{R}_1$, $[\mathrm{ev}, u_3, utt] \rightarrow \mathrm{S}_1$, $[\mathrm{time}, utt] \rightarrow \mathrm{T}_1$,
$[\mathrm{res}, u_1] \rightarrow \mathrm{Rs}_1$, $[\mathrm{bg}, u_1] \rightarrow \mathrm{B}_1$, $[\mathrm{res}, u_2] \rightarrow \mathrm{Rs}_2$, $[\mathrm{etr}, u_4, utt] \rightarrow \mathrm{T}_2$, $[\mathrm{bg}, u_4] \rightarrow \mathrm{B}_2$, $[\mathrm{res}, u_4] \rightarrow \mathrm{Rs}_3$,
$[\mathrm{subj}, u_5] \rightarrow \mathrm{X}_2$, $[\mathrm{obj}, u_6] \rightarrow \mathrm{Y}_2$, $[\mathrm{pred}, u_7] \rightarrow \mathrm{R}_2$, $[\mathrm{ev}, u_8, utt_2] \rightarrow \mathrm{S}_2$, $[\mathrm{time}, utt_2] \rightarrow \mathrm{T}_3$,
$[\mathrm{res}, u_5] \rightarrow \mathrm{Rs}_3$, $[\mathrm{bg}, u_5] \rightarrow \mathrm{B}_3$, $[\mathrm{res}, u_6] \rightarrow \mathrm{Rs}_4$, $[\mathrm{bg}, u_9] \rightarrow \mathrm{B}_4$

S_1

$\mathrm{R}_1(\mathrm{X}_1, \mathrm{Y}_1, \mathrm{T}_1)$

S_1: EVENT

$\mathrm{S}_1, \mathrm{R}_1(\mathrm{X}_1, \mathrm{Y}_1, \mathrm{T}_1)$: KEY

Rs_1: named(X_1, 'Daniel')

Rs_2: named(Y_1, 'Ben Nevis')

B_1: male(X_1)

Rs_3: named(T_2, 'July')

B_2: $\mathrm{T}_1 \sqsubseteq \mathrm{T}_2$

S_2

$\mathrm{R}_2(\mathrm{X}_2, \mathrm{Y}_2, \mathrm{T}_3)$

S_2: EVENT

$\mathrm{S}_2, \mathrm{R}_2(\mathrm{X}_2, \mathrm{Y}_2, \mathrm{T}_3)$: KEY

Rs_3: named(X_2, 'Owen')

Rs_4: named(Y_2, 'Snowdon')

B_3: male(X_2)

Rs_3: named(T_2, 'July')

B_4: $\mathrm{T}_3 \sqsubseteq \mathrm{T}_2$

{8}

where $[[\mathrm{pred}, u] \rightarrow \mathrm{climb},\ [\mathrm{pred}, u_7] \rightarrow \mathrm{climb}] \subseteq f$.

The rule for PART-OF 'then' is also tried, but since it requires that the eventuality in the current sentence is of type STATE, this will fail here as S_2 is of type EVENT. Thus no reading for PART-OF 'then' is obtained for (3.28a,3.28b), which is what the analysis of Chapter 2 requires.

Now consider the sequence:

(3.29) a. Daniel climbed Ben Nevis

b. Owen climbed Snowdon then

Processing of (3.29a) gives the DRS $\{1\}$. Processing of (3.29b) up to S level (i.e., as far as 'then') gives the DRS $\{5\}$, as in the previous example. Now, once again, we come to the rule:

$S' \rightarrow S, \text{AdvP}$

which means that we must parse 'then' as an AdvP. This in turn means that we must parse 'then' as an Adv, as before. We must therefore parse 'then' according to either the ETR 'then' or the PART-OF 'then' rule (or both).

The rule for ETR 'then' requires that:

$[\text{etr}, u, utt'] \in in$

where utt' is an earlier utterance of an ETR. But after parsing (3.29a), *out* is equal to:

$\{[\text{subj}, u_1], [\text{obj}, u_2], [\text{ev}, u_3, utt], [\text{time}, utt]\}$

and this, of course, is *in* for the processing of (3.29b). But there is no referent here of the form $[\text{etr}, u, utt']$, and so the rule for ETR 'then' fails.

Next we try to parse 'then' using the PART-OF rule. This rule requires that the eventuality described by the current utterance is a state, i.e. that:

$$u_1 \models \begin{bmatrix} \text{ev-type: state} \end{bmatrix}$$

But in (3.29b) the described eventuality is an event, i.e.:

$$u_1 \models \begin{bmatrix} \text{ev-type: event} \end{bmatrix}$$

where u_1 is the utterance of the eventuality in (3.29b). Therefore the rule for PART-OF 'then' fails too.

Thus both rules for sentence-final 'then' have failed and there is no parse for (3.29a,3.29b).

Now suppose we replace (3.29b) with a state, to give the sequence:

(3.30) a. Daniel climbed Ben Nevis

b. Emily liked Fiona then

The rule for ETR 'then' will still fail as there is no ETR, but since (3.30b) is stative:

$$u_1 \models \begin{bmatrix} \text{ev-type: state} \end{bmatrix}$$

where u_1 is the utterance of the eventuality in (3.30b).

The rule for PART-OF 'then' requires that:

$[\text{ev}, u, utt'] \in in$

where *utt'* is the utterance of the previous sentence. Now *in* for (3.30b) is equal to:

$\{[\text{subj}, u_1], [\text{obj}, u_2], [\text{ev}, u_3, utt], [\text{time}, utt]\}$

where *utt* is the utterance of (3.30a) — i.e., the utterance of the previous sentence. The requirement is therefore fulfilled and the rule for PART-OF 'then' succeeds. The information that the eventuality described by (3.30b) is PART-OF the one described by (3.30a) is added to the overall DRS, giving {9}:

$[\mathrm{subj}, u_1] \to \mathrm{X}_1$, $[\mathrm{obj}, u_2] \to \mathrm{Y}_1$, $[\mathrm{pred}, u] \to \mathrm{R}_1$, $[\mathrm{ev}, u_3, utt] \to \mathrm{S}_1$,
$[\mathrm{time}, utt] \to \mathrm{T}_1$, $[\mathrm{res}, u_1] \to \mathrm{Rs}_1$, $[\mathrm{bg}, u_1] \to \mathrm{B}_1$, $[\mathrm{res}, u_2] \to \mathrm{Rs}_2$,
$[\mathrm{subj}, u_4] \to \mathrm{X}_2$, $[\mathrm{obj}, u_5] \to \mathrm{Y}_2$, $[\mathrm{pred}, u_6] \to \mathrm{R}_2$, $[\mathrm{ev}, u_7, utt_2] \to \mathrm{S}_2$, $[\mathrm{time}, utt_2] \to \mathrm{T}_2$,
$[\mathrm{res}, u_4] \to \mathrm{Rs}_3$, $[\mathrm{bg}, u_4] \to \mathrm{B}_2$, $[\mathrm{res}, u_5] \to \mathrm{Rs}_4$, $[\mathrm{bg}, u_5] \to \mathrm{B}_3$, $[\mathrm{bg}, u_8] \to \mathrm{B}_4$

S_1

$\mathrm{R}_1(\mathrm{X}_1, \mathrm{Y}_1, \mathrm{T}_1)$

S_1: EVENT

$\mathrm{S}_1, \mathrm{R}_1(\mathrm{X}_1, \mathrm{Y}_1, \mathrm{T}_1)$: KEY

Rs_1: named(X_1, 'Daniel')

Rs_2: named(Y_1, 'Ben Nevis')

B_1: male(X_1)

S_2

$\mathrm{R}_2(\mathrm{X}_2, \mathrm{Y}_2, \mathrm{T}_2)$

S_2: STATE

$\mathrm{S}_2, \mathrm{R}_2(\mathrm{X}_2, \mathrm{Y}_2, \mathrm{T}_2)$: KEY

Rs_3: named(X_2, 'Emily')

B_2: female(X_2)

Rs_4: named(Y_2, 'Fiona')

B_3: female(Y_2)

B_4: $\mathrm{S}_2 \trianglelefteq \mathrm{S}_1$

{9}

where:

$[[\mathrm{pred}, u] \to \mathrm{climb}, [\mathrm{pred}, u_6] \to \mathrm{like}] \subseteq f$.

A similar result is obtained for (3.31a,3.31b):

(3.31) a. Daniel climbed Ben Nevis

b. Owen was climbing Snowdon then

Here, the rule for PART-OF 'then' succeeds once again, in this case because (3.31b) is progressive, and progressives count as stative in this fragment. Hence, if u is the utterance of the eventuality in (3.31b):

$$u \models \begin{bmatrix}\text{ev-type: state}\end{bmatrix}$$

The overall DRS for (3.31a,3.31b) is $\{10\}$:

$[\text{subj}, u_1] \rightarrow X_1$, $[\text{obj}, u_2] \rightarrow Y_1$, $[\text{pred}, u] \rightarrow R_1$, $[\text{ev}, u_3, utt] \rightarrow S_1$,
$[\text{time}, utt] \rightarrow T_1$, $[\text{res}, u_1] \rightarrow Rs_1$, $[\text{bg}, u_1] \rightarrow B_1$, $[\text{res}, u_2] \rightarrow Rs_2$,
$[\text{subj}, u_4] \rightarrow X_2$, $[\text{obj}, u_5] \rightarrow Y_2$, $[\text{pred}, u_6] \rightarrow R_2$, $[\text{ev}, u_7, utt_2] \rightarrow S_2$, $[\text{time}, utt_2] \rightarrow T_2$,
$[\text{res}, u_4] \rightarrow Rs_3$, $[\text{bg}, u_4] \rightarrow B_2$, $[\text{res}, u_5] \rightarrow Rs_4$, $[\text{bg}, u_8] \rightarrow B_4$

S_1

$R_1(X_1, Y_1, T_1)$

S_1	$S_1, R_1(X_1, Y_1, T_1)$
EVENT	KEY

Rs_1	Rs_2
named(X_1, 'Daniel')	named(Y_1, 'Ben Nevis')

B_1
male(X_1)

S_2

$R_2(X_2, Y_2, T_2)$

S_2	$S_2, R_2(X_2, Y_2, T_2)$
STATE	KEY

Rs_3	B_2
named(X_2, 'Owen')	male(X_2)

Rs_4	B_4
named(Y_2, 'Snowdon')	$S_2 \trianglelefteq S_1$

{10}

where:

$[[\text{pred},u] \rightarrow \text{climb}, [\text{pred},u_6] \rightarrow \text{climbing}] \subseteq \text{f}$.

Finally, consider the sequence:

(3.32) a. Daniel climbed Ben Nevis in July

b. Owen was climbing Snowdon then

This time, there is an ETR, 'July', in (3.32a), and so the rule for ETR 'then' succeeds, giving the overall DRS {11}:

$[\mathrm{subj}, u_1] \to \mathrm{X}_1$, $[\mathrm{obj}, u_2] \to \mathrm{Y}_1$, $[\mathrm{pred}, u] \to \mathrm{R}_1$, $[\mathrm{ev}, u_3, utt] \to \mathrm{S}_1$, $[\mathrm{time}, utt] \to \mathrm{T}_1$,
$[\mathrm{res}, u_1] \to \mathrm{Rs}_1$, $[\mathrm{bg}, u_1] \to \mathrm{B}_1$, $[\mathrm{res}, u_2] \to \mathrm{Rs}_2$, $[\mathrm{etr}, u_4, utt] \to \mathrm{T}_2$, $[\mathrm{bg}, u_4] \to \mathrm{B}_2$, $[\mathrm{res}, u_4] \to \mathrm{Rs}_3$,
$[\mathrm{subj}, u_5] \to \mathrm{X}_2$, $[\mathrm{obj}, u_6] \to \mathrm{Y}_2$, $[\mathrm{pred}, u_7] \to \mathrm{R}_2$, $[\mathrm{ev}, u_8, utt_2] \to \mathrm{S}_2$, $[\mathrm{time}, utt_2] \to \mathrm{T}_3$,
$[\mathrm{res}, u_5] \to \mathrm{Rs}_3$, $[\mathrm{bg}, u_5] \to \mathrm{B}_3$, $[\mathrm{res}, u_6] \to \mathrm{Rs}_4$, $[\mathrm{bg}, u_9] \to \mathrm{B}_4$

S_1: $\mathrm{R}_1(\mathrm{X}_1, \mathrm{Y}_1, \mathrm{T}_1)$ ‖

- S_1: EVENT
- $\mathrm{S}_1, \mathrm{R}_1(\mathrm{X}_1, \mathrm{Y}_1, \mathrm{T}_1)$: KEY
- Rs_1: named(X_1, 'Daniel')
- Rs_2: named(Y_1, 'Ben Nevis')
- B_1: male(X_1)
- Rs_3: named(T_2, 'July')
- B_2: $\mathrm{T}_1 \sqsubseteq \mathrm{T}_2$

S_2: $\mathrm{R}_2(\mathrm{X}_2, \mathrm{Y}_2, \mathrm{T}_3)$ ‖

- S_2: STATE
- $\mathrm{S}_2, \mathrm{R}_2(\mathrm{X}_2, \mathrm{Y}_2, \mathrm{T}_3)$: KEY
- Rs_3: named(X_2, 'Owen')
- Rs_4: named(Y_2, 'Snowdon')
- B_3: male(X_2)
- Rs_3: named(T_2, 'July')
- B_4: $\mathrm{T}_3 \circ \mathrm{T}_2$

{11}

where:

$[[\text{pred},u] \rightarrow \text{climb}, [\text{pred},u_7] \rightarrow \text{climbing}] \subseteq \text{f}.$

The rule for PART-OF 'then' also succeeds, as (3.32b) is progressive (stative). Parsing by this rule gives the overall DRS $\{12\}$:

$[\mathrm{subj}, u_1] \rightarrow \mathrm{X_1}$, $[\mathrm{obj}, u_2] \rightarrow \mathrm{Y_1}$, $[\mathrm{pred}, u] \rightarrow \mathrm{R_1}$, $[\mathrm{ev}, u_3, utt] \rightarrow \mathrm{S_1}$, $[\mathrm{time}, utt] \rightarrow \mathrm{T_1}$,
$[\mathrm{res}, u_1] \rightarrow \mathrm{Rs_1}$, $[\mathrm{bg}, u_1] \rightarrow \mathrm{B_1}$, $[\mathrm{res}, u_2] \rightarrow \mathrm{Rs_2}$, $[\mathrm{etr}, u_4, utt] \rightarrow \mathrm{T_2}$, $[\mathrm{bg}, u_4] \rightarrow \mathrm{B_2}$, $[\mathrm{res}, u_4] \rightarrow \mathrm{Rs_3}$,
$[\mathrm{subj}, u_5] \rightarrow \mathrm{X_2}$, $[\mathrm{obj}, u_6] \rightarrow \mathrm{Y_2}$, $[\mathrm{pred}, u_7] \rightarrow \mathrm{R_2}$, $[\mathrm{ev}, u_8, utt_2] \rightarrow \mathrm{S_2}$, $[\mathrm{time}, utt_2] \rightarrow \mathrm{T_3}$,
$[\mathrm{res}, u_5] \rightarrow \mathrm{Rs_3}$, $[\mathrm{bg}, u_5] \rightarrow \mathrm{B_3}$, $[\mathrm{res}, u_6] \rightarrow \mathrm{Rs_4}$, $[\mathrm{bg}, u_9] \rightarrow \mathrm{B_4}$

$\mathrm{S_1}$

$\mathrm{R_1(X_1, Y_1, T_1)}$

$\mathrm{S_1}$	$\mathrm{S_1, R_1(X_1, Y_1, T_1)}$
EVENT	KEY

$\mathrm{Rs_1}$	$\mathrm{Rs_2}$
named($\mathrm{X_1}$, 'Daniel')	named($\mathrm{Y_1}$, 'Ben Nevis')

$\mathrm{B_1}$	$\mathrm{Rs_3}$
male($\mathrm{X_1}$)	named($\mathrm{T_2}$, 'July')

$\mathrm{B_2}$
$\mathrm{T_1 \sqsubseteq T_2}$

$\mathrm{S_2}$

$\mathrm{R_2(X_2, Y_2, T_3)}$

$\mathrm{S_2}$	$\mathrm{S_2, R_2(X_2, Y_2, T_3)}$
STATE	KEY

$\mathrm{Rs_3}$	$\mathrm{B_3}$
named($\mathrm{X_2}$, 'Owen')	male($\mathrm{X_2}$)

$\mathrm{Rs_4}$
named($\mathrm{Y_2}$, 'Snowdon')

$\mathrm{B_4}$
$\mathrm{S_2 \trianglelefteq S_1}$

{12}

where:

$[[\text{pred},u] \rightarrow \text{climb}, [\text{pred},u_7] \rightarrow \text{climbing}] \subseteq \text{f}$.

Thus two readings are obtained for (3.32a,3.32b), in accordance with our observations and analysis of Chapter 2. The first corresponds to ETR 'then' and the second to PART-OF 'then'.

We have therefore demonstrated that our DSTG grammar generates the required readings for sequences containing sentence-final 'then'.

3.8 Conclusion

We have presented a grammatical fragment expressed in a situation theory / DRT framework (DSTG), and have demonstrated how it generates the readings for sentence-final 'then' in accordance with the observations and analysis of Chapter 2. The DSTG grammar relies crucially on the ability of situation theory to encode and make use of information about the utterance. The grammar allows temporal discourse referents to be introduced both in cases of explicit temporal reference and in those where temporal reference is merely implicit. In addition, we encode whether or not a particular temporal referent was introduced by means of an ETR. This gives us added flexibility over our DRT fragment in Chapter 2, where we allowed a time referent to be introduced only in the case of an ETR. We argued earlier that this kind of flexibility may well be useful in larger fragments. In Chapter 4 we will develop an account of 'at the time' and 'at the same time' in STDRT where we rely on being able to introduce temporal discourse referents even in cases where there is no ETR.

The addition of situations to the fragment allows us to use formally defined situation-theoretic notions such as '$\trianglelefteq$' to express relations between eventualities. The notion of situations supporting infons also gives us a natural semantics for the proposal in (Kamp and Reyle 1993) that the type of an event is specified by conditions in the DRS.

In Chapter 5 we will show that situations are also useful in allowing us to develop an account of event structure needed for the treatment of aspectual class and aspectual composition.

Chapter 4

'The same X' and 'the X': an STDRT account

Note: Material from this chapter was presented at the ASL/LSA Conference in Logic and Linguistics, The Ohio State University, Columbus, Ohio, July 1993 (see Glasbey 1993b). Further developments of some of the work in this chapter were presented at the conference 'Events and Grammar' held at Bar-Ilan University, Israel, November 1993, and at the Ninth Amsterdam Colloquium, University of Amsterdam, December 1993. The latter is reported in (Glasbey 1994a).

4.1 Introduction

The motivation behind the work presented in this chapter is to give a more satisfactory and complete account of 'at the time' and 'at the same time', which were briefly discussed in Chapter 2. In order to try to understand the distribution and meaning of these phrases, we will begin by looking at 'the X' and 'the same X', where X is a relational noun such as 'colour'. We will then attempt to apply our findings for the non-temporal cases to the temporal examples.

Before we begin, we should make it clear that in this chapter we will be expressing our account in terms of STDRT (Cooper 1993b, 1993c), not in the DSTG we developed in Chapter 3. Although the two are related, there are some important differences which were discussed in Chapter 3.

First, let us recall our observations about the distribution of sentence-final 'at the time' and 'at the same time', made in Chapter 2. We saw that a sequence of two sentences where the second ends in 'at the time' requires that the second sentence is either a stative or a progressive. For example:

(4.1)
a. Emily climbed Ben Nevis
b. *Fiona climbed Snowdon at the time
c. Fiona was a young girl at the time
d. Fiona was climbing Snowdon at the time

(4.1a,4.1b), where the second sentence is neither stative nor progressive is not acceptable. By contrast, (4.1a,4.1c) and (4.1a,4.1d) are both acceptable.

We saw that 'at the same time', on the other hand, requires that if the first sentence describes an event then the second must also describe an event as opposed to a state. Thus (4.2a,4.2b) is acceptable and (4.2a,4.2c) is not.

(4.2)
a. Emily climbed Ben Nevis
b. Fiona climbed Snowdon at the same time
c. *Fiona was a girl at the same time

We also noted that either 'at the same time' or 'at the time' is acceptable if the second sentence is a progressive. Thus:

(4.3)
a. Emily climbed Ben Nevis
b. Fiona was climbing Snowdon at the time

and:

(4.4) a. Emily climbed Ben Nevis

b. Fiona was climbing Snowdon at the same time

are both acceptable.

In order to account for these observations, we will look first at 'the X' and 'the same X', where X is a relational noun such as 'colour'. We will then apply the account we develop for the non-temporal cases to the temporal examples.

We will begin by making some observations about the distribution of 'the X' and 'the same X' in discourse, presenting examples of two-sentence sequences like:

(4.5) a. Emily has a new coat

b. Fiona likes the colour

and:

(4.6) a. Emily has a new coat

b. Fiona's scarf is the same colour

We will use these to identify the conditions in which 'the X' and 'the same X' are appropriate. We are therefore concerned here with what Carlson (1987) calls **sentence-external** uses of 'the same', where the referent of 'the same X' was introduced by the preceding sentence (as in (4.6) above). Initially, we give an informal account which employs the notion of **role anaphora** taken from the psycholinguistic and AI literature (see, for example, Garrod and Sanford 1990). From this we develop a formal account expressed in the EKN notation developed by Barwise and Cooper (1993), using the situation theoretic DRT framework of (Cooper 1993b, 1993c) (see Chapter 3 for details of both of these).

We will then move on to consider non-relational uses of 'the same', such as:

(4.7) a. Emily watched a film

b. Fiona recorded the same film

We call this use 'non-relational' because 'the same film' in (4.7b) refers to an entity that was *explicity* introduced in (4.7a). This contrasts with (4.6a,4.6b), where 'the same colour' in (4.6b) refers to an entity which was not explicitly introduced by the previous sentence.

We also examine sentence-internal examples such as:

(4.8) Emily watched and Fiona recorded the same film

and non-acceptable examples such as:

(4.9) *Emily watched and Fiona liked the same film

In attempting to extend our initial analysis to the non-relational cases we show that it is inadequate in some respects. This leads us to develop a modified account which accommodates both relational and non-relational cases and, in addition, deals with the examples that were problematic for the initial account.

Finally, we turn to the temporal expressions 'at the time' and 'at the same time'. We show how our account for the non-temporal examples can be used to explain the distribution of these phrases, and how this points towards a theory of **discourse backgrounding**.

Our analysis will demonstrate the important part played by accommodation and inference in the interpretation of these constructions, and the need to take into account the distinction between information directly conveyed by an utterance and information that may be inferred from it.

4.2 'The same X' and 'the X'

4.2.1 Observations

Consider the following two-sentence sequences, where (4.10a) is followed by one of (4.10b), (4.10c), (4.10d) and (4.10e).

(4.10) a. Emily has a new coat
b. Fiona likes the colour
c. *Fiona's scarf is the colour
d. Fiona's scarf is the same colour
e. %Fiona likes the same colour

A single asterix indicates that the sequence is judged unacceptable. The '%' sign before (4.10e) means that (4.10a,4.10e) is acceptable only under certain conditions, to be explained below.

How can we account for the fact that 'the colour' is acceptable in (4.10a,4.10b) but not in (4.10a,4.10c), where we must use not 'the colour' but 'the same colour'?[1] First, we need to consider what exactly is conveyed by the use of 'the colour' in, for example, (4.10a,4.10b). In ordinary (non-relational) uses of definite descriptions, 'the X' refers to an entity already present in the discourse context. In DRT (Kamp 1981, Kamp and Reyle 1993), this is formalized by requiring the referent to be a discourse referent present in the universe of discourse of a currently accessible discourse representation structure (DRS). In the situation theoretic approach of Cooper (1993a), a resource situation supports the fact that the referent is the unique object meeting the description.

But in (4.10a,4.10b), something different is going on. Suppose that (4.10a) is the first sentence of a discourse. Then, at the time that (4.10b) is uttered, there has been no mention of any 'colour', and thus no suitable discourse referent is

[1]Indeed, it appears that not only is the sequence (4.10a,4.10c) unacceptable, but there seems to be something wrong with (4.10c) in itself. We were unable to think of any context in which (4.10c) is acceptable. The explanation which we propose below will allow us to explain the unacceptability of (4.10c), as well as that of the sequence (4.10a,4.10c).

present in the current DRS. Yet we have no difficulty in interpreting (4.10a,4.10b) as a coherent piece of discourse. Clearly, some kind of inference is being made in order to allow us to interpret the phrase 'the colour'. The inference that we make, apparently without undue effort, is that 'the colour' in (4.10b) refers to the colour of Emily's new coat. Of course, this can be expressed more explicitly by the paraphrase:

(4.11) a. Emily has a new coat
b. Fiona likes the colour of Emily's new coat

Or:

(4.12) a. Emily has a new coat
b. Fiona likes its colour

Nouns like 'colour' are often referred to as **relational nouns** because of their ability to be used in this way. The notion is very similar to that of **role anaphora** in the psycholinguistics literature (see Garrod and Sanford 1990 for details, and our brief introduction to role anaphora in Chapter 2). To recap briefly on that discussion: role anaphora is distinguished from what is normally thought of as anaphora (**individual** or **pronominal** anaphora) as follows. Individual anaphora involves reference by pronouns[2] to entities that have already been explicitly introduced by the preceding discourse. Such entities can be thought of as roughly corresponding to discourse referents in DRT. An example is the sequence:

(4.13) a. Mary has a new car
b. It is very reliable

where the pronoun 'it' in (4.13b) refers to the entity introduced by 'a new car' in (4.13a).

[2]Or by definite descriptions.

Role anaphora, on the other hand, involves reference to entities which have not been introduced by explicit mention in the preceding discourse. Such entities may sometimes be referred to by using a definite noun phrase, as in:

(4.14) a. Mary drove to London

b. The car broke down on the motorway

Here, 'the car' in (4.14b) is understood to refer to the car that Mary drove to London, although there is no mention of a car in (4.14a). Just as in (4.10a,4.10b), we have no difficulty in understanding (4.14a,4.14b) — we appear to make without effort the required inference that the car was the one that Mary drove to London. Of course if (4.14b) had been preceded by (4.15a):

(4.15) a. Mary wrote a report

we would have difficulty in making any sense of the sequence. Clearly, mention of a drive in (4.14a) in some way makes available the entity referred to by 'the car' in (4.14b). Intuitively, this is because we readily associate a car with a drive. Consider:

(4.16) a. Mary went for an interview

b. The car broke down on the motorway

This is easier to interpret than (4.15a,4.14b), although it requires rather more effort than (4.14a,4.14b) We appear to have little difficulty in making the necessary inference to the effect that Mary travelled to her interview by car, and that it was this car that broke down on the motorway.

Thus we see that mention of certain kinds of event (e.g. a driving event in (4.14a)) serves in some way to make available a "car" role,[3] which may be referred to by a

[3]Or perhaps, more generally, a "vehicle" role.

definite NP in the next sentence. (From now on we will use capitalised 'Role' to refer to the role anaphora kind of role, in order to avoid confusion with situation theoretic roles, which we will be using shortly.)

We have also seen from (4.16a,4.16b) that the car Role may be made available less directly, in cases where we are able to infer that a drive constituted part of the described event. We saw too from (4.10a,4.10b) that the mention of a coat makes available a 'colour' Role.[4]

Such a Role could be seen in situation-theoretic terms as a two-place relation holding between an object (the first argument) and its colour (the second argument). We can use this relation to form an infon such as:

colour-of(X,Y)

where the argument roles of **colour-of** would have minimal appropriateness conditions specifying that X is a physical object and Y is a colour.[5]

Thus EKN gives us a straightforward way to formalize the notion of Role used in role anaphora. Note, however, that at the point in the discourse where (4.10a) has just been uttered, there is no reason to introduce the **colour-of** Role. Indeed, the idea of doing this seems very implausible. If we were required to introduce all the possible Roles resulting from the mention of a given object, we might well require an enormous number of Roles. This might well present problems for a formal account. In addition, if we consider Roles to be in some way psychologically "real"[6] (e.g. as mental entities present in some way in the current focus of speaker

[4]Indeed, we could perhaps see this as a general constraint applying to the class of "physical objects", the mention of one of which makes available a colour Role. However, it appears that 'colour-of' is a more relevant attribute for some objects than for others. Consider, for example:

(4.17) a. Mary bought a new engine

b. John admired the colour

which sounds rather odd, presumably because we are not used to thinking of engines as having colours, or, at least, the colour of an engine seems somewhat irrelevant or unimportant.

[5]See Chapter 3 for an explanation of the box notation (known as EKN) used here.

[6]As Garrod and Sanford do, for example.

and hearer), then the idea of such a multiplicity of possible Roles becomes more unlikely than ever. It appears much more sensible to introduce the appropriate Role only after utterance of the sentence which picks out this Role.

A more plausible account would be one where the hearer after the first utterance does not explicitly believe that the coat in question has a colour, but where she believes that C is a coat and that coats have colours. This allows her to move, after the second utterance, into a new mental state where she has the explicit belief that C has a colour. Such a view of reasoning as transitions between mental states ties in with work by Cooper and Ginzburg (1993), and could be expressed in their framework. This matter also relates to what has been called "tacit belief", as discussed in (Crimmins 1992), for example. Clearly, there are issues here which should be explored further.

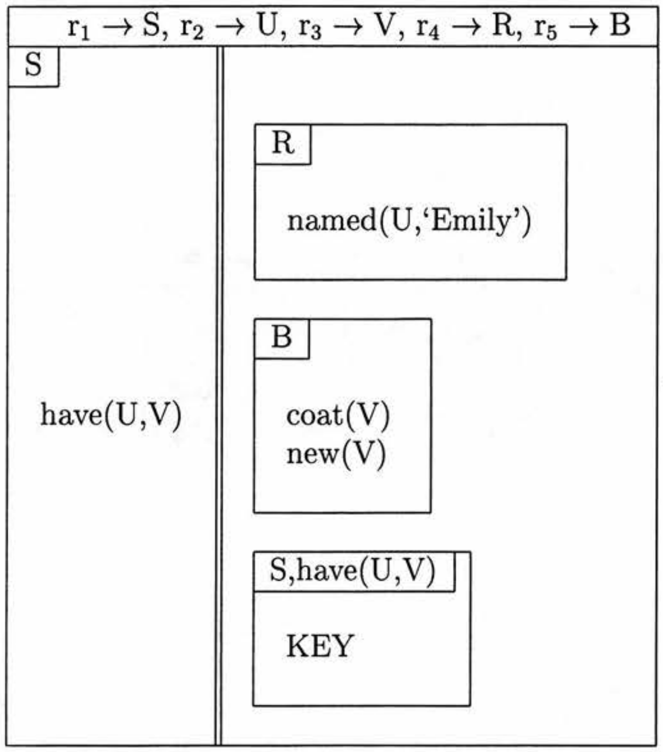
Let us attempt to represent (4.10a–4.10e) in EKN notation, using the ideas developed above.

4.2.2 EKN representations

We will ignore temporal information in this section.

First, consider (4.10a,4.10b). For (4.10a), we would obtain the representation {1} below.[7]

[7]We use here the DRT treatment of indefinites, and Cooper's treatment of proper names in situation theory (Cooper 1993a).



{1}

Note that we should strictly treat the adjective 'new' as a predicate modifier. We express it as above for simplicity, and our account does not depend on this treatment in any way.

A first attempt at a representation for (4.10b) would give us:

$r_6 \rightarrow S$, $r_7 \rightarrow U$, $r_8 \rightarrow V$, $r_9 \rightarrow R$, $r_{10} \rightarrow B$

<table>
<tr><td>S

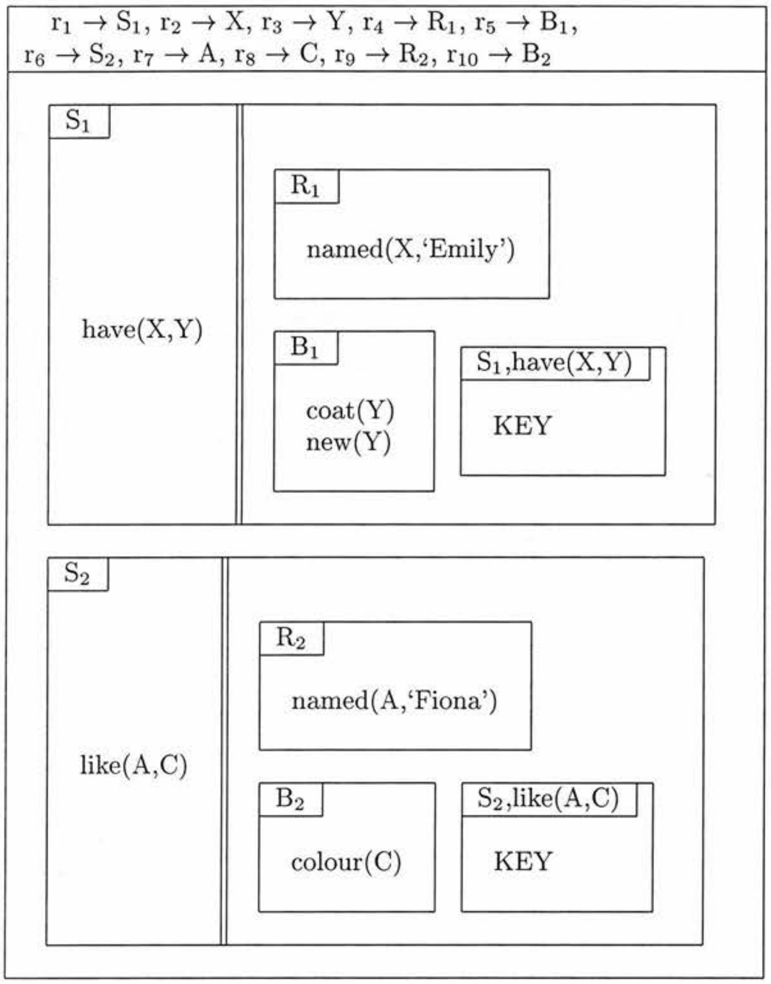
like(U,V)</td><td>R
named(U,'Fiona')

B
colour(V)

S,like(U,V)
KEY</td></tr>
</table>

{2}

Now we combine the two with the $\oplus$ operation of (Cooper 1993c) (see Chapter 3, Section 3.4.3 for explanation). Assigning new parameters and abstracting over these gives us the conjoined DRS {3}:



{3}

There is nothing here, however, to link the colour that Fiona likes (corresponding to the discourse role r_8) with the colour of Emily's coat. We must add a **colour-of** Role to the type/DRS {1} corresponding to the inference we make while or after processing (4.10b). This incorporation of extra information into {1} while/after processing a later sentence is a kind of accommodation process (see Lewis 1979). It is not that the hearer needs to infer, presumably, that a coat has a colour. What is involved is something more akin to a focusing upon the colour attribute of the coat. The colour becomes relevant to the interpretation of the discourse, and we represent this by incorporating information about the **colour-of** role into {1}.

But where should we put this information? Perhaps it should go not in {1} but in {2}, in order to reflect the order of processing? In situation theoretic terms it makes no difference whether we add this information to the restrictions of {1} or to those of {2}. This is because restrictions distribute over conjunction (see

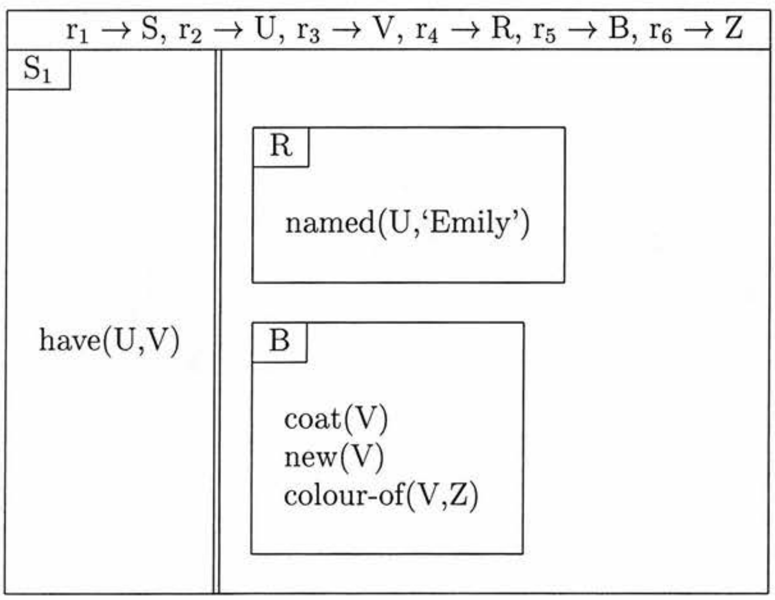
Barwise and Cooper 1993. However, in DRT terms it seems to make more sense to add this information to {1}. This would allow us to explain:

(4.18) a. Emily did not buy a new coat
b. *Fiona liked the colour

in terms of the inaccessibility of the "colour" referent resulting from the negation in (4.18a).

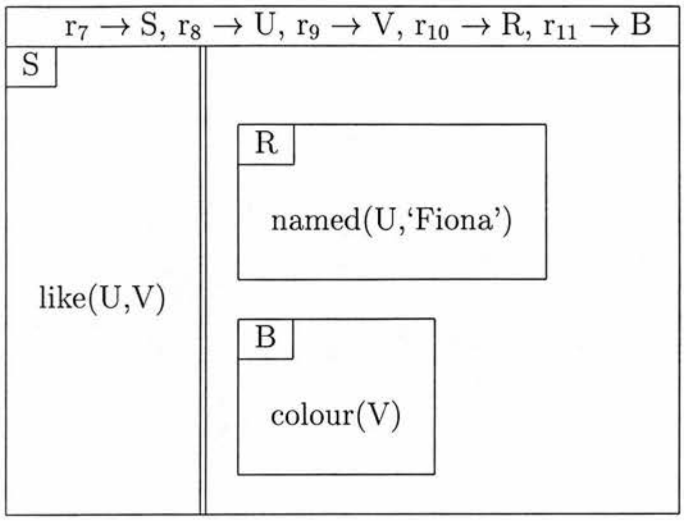
Thus our second attempt at EKN representations for (4.10a) and (4.10b) is as follows. (We will drop the information that the situation and infon are of type KEY from now on, in order to save space, and take this information to be understood.)

(4.10a):



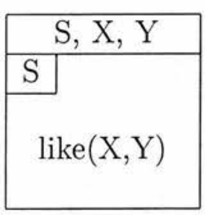
{1′}

(4.10b):

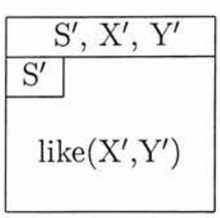


$\{2'\}$

We have still not expressed that the object of Fiona's liking is the same as the colour of Emily's coat. Gawron and Peters (1990) use parameter sharing in order to express sentence-internal anaphora in situation semantics. However, things are a little complicated here in that we have abstracted over the parameters to form a type. Once we have abstracted over a parameter, that parameter is no longer present in the semantic object, and the two boxes:

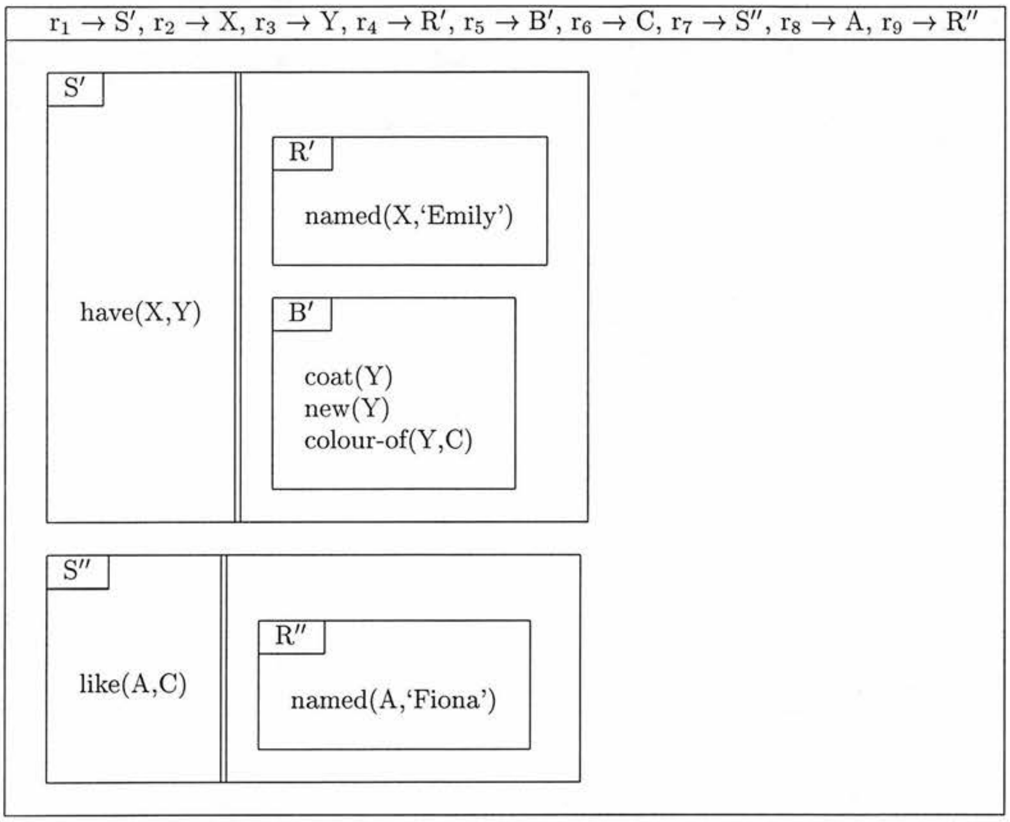


and:



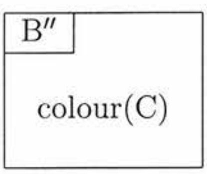
represent exactly the same object.

Hence the sharing of parameters across types where these parameters have been abstracted over is meaningless. For this reason, Cooper (1993c) uses the sharing not of parameters but of **roles** in order to capture anaphoric relations. Using this approach we can express the required anaphoric relation by merging the roles r_6 and r_9. Having done this, we assign new parameters to the roles of the conjoined type. Cooper's $\oplus$ operation (see the definition in Chapter 3, Section 3.4.3) ensures that the result of merging roles r_6 and r_9 is that the same parameter will now be assigned to the role that is the colour of Emily's coat and to the role that is the thing that Fiona likes. This gives us the conjoined type:



{3′}

Note that we have dropped the proposition:



from the restrictions of the second type, as this information is subsumed by:

B′

colour-of(Y,C)

Now that we have found a way to express the meaning of (4.10a,4.10b) in our chosen notation, let us move on to try to explain why it is not possible to follow:

(4.10) a. Emily has a new coat

with:

(4.10) c. Fiona's scarf is the colour

There is nothing obvious here to get in the way of our constructing a similar representation to the one for (4.10a,4.10b). Suppose we try to do this. (4.10a) would give the same representation as before, of course (see {1}). For (4.10c) we would obtain the type:

$r_7 \rightarrow S$, $r_8 \rightarrow W$, $r_9 \rightarrow V$, $r_{10} \rightarrow R$, $r_{11} \rightarrow U$, $r_{12} \rightarrow B$

S

colour-of(W,V)

R

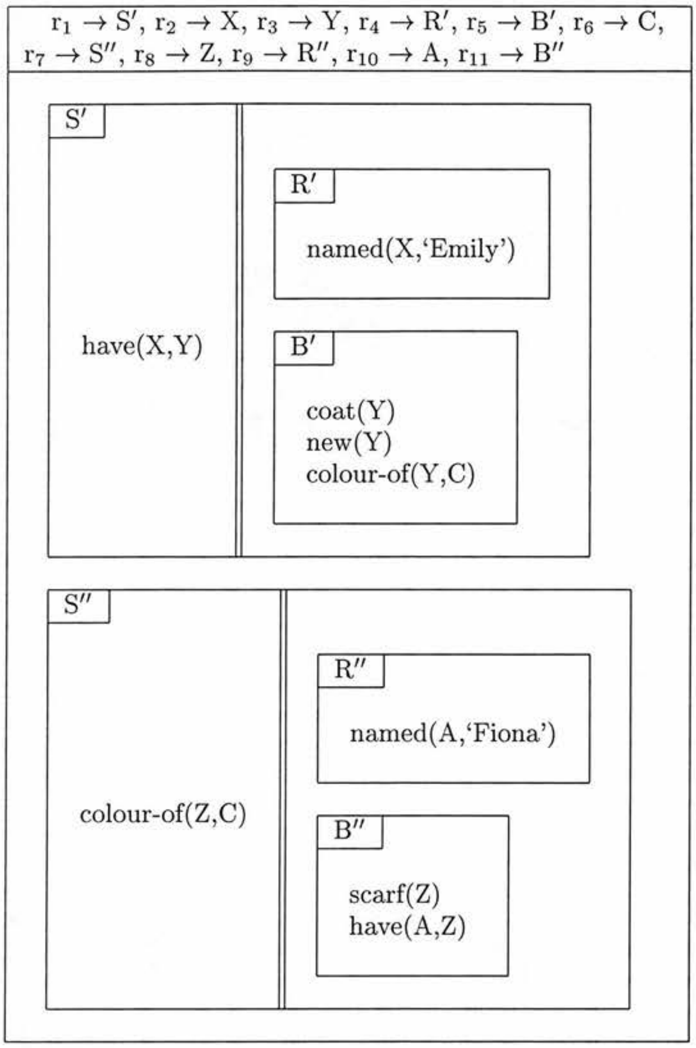
named(U,'Fiona')

B

scarf(W)
have(U,W)

{4}

Conjoining {1} and {4} using $\oplus$ as in the previous example gives us:



{5}

In exactly the same way as before, the merging of roles results in the same parameter C being assigned to the role corresponding to the colour of Emily's coat and the role corresponding to the colour of Fiona's scarf. How, then, can we explain the unacceptability of (4.10a,4.10c) and the fact that we must follow (4.10a) with (4.10d) in order to convey the desired meaning? We propose the following explanation.

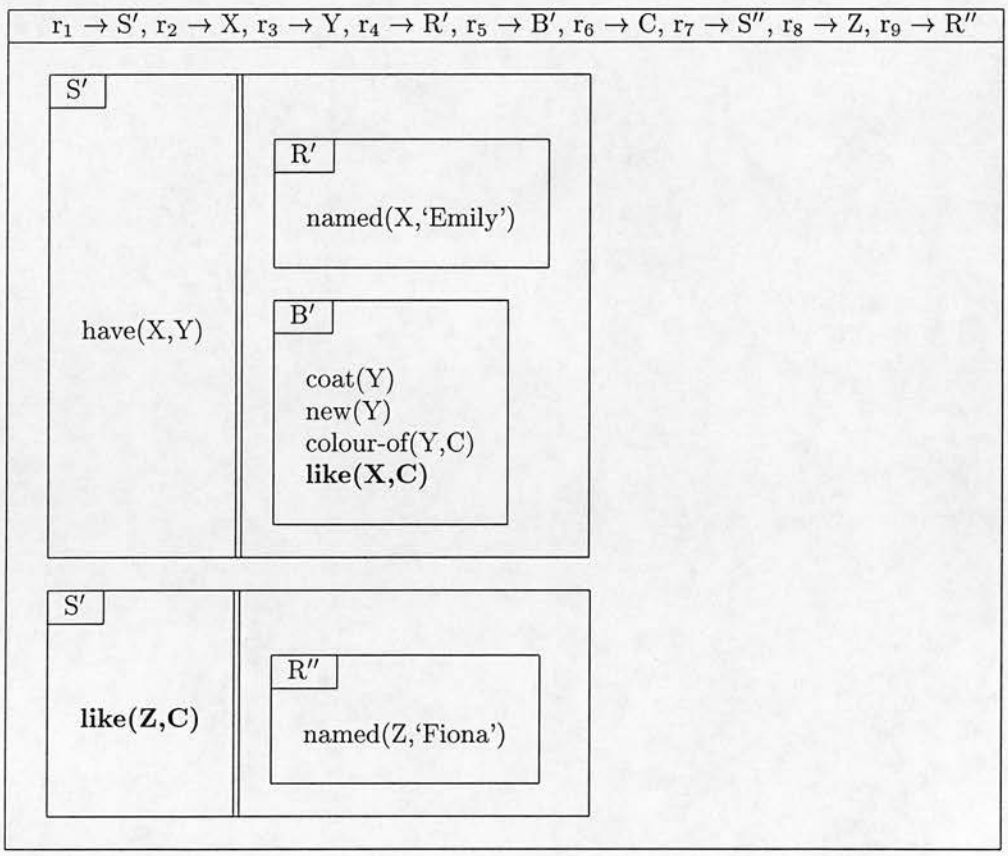
4.2.3 Proposal

The difference between this example and the previous one is that here we have not one but two **colour-of** Roles. This suggests that if more than one Role of the same kind is present, we must use 'the same X' rather than 'the X'. Let us test this suggestion by looking at (4.10a,4.10e).

(4.10) a. Emily has a new coat

e. %Fiona likes the same colour

This sequence is only acceptable under certain conditions. In order to interpret it, we must make the inference that "Emily likes the colour of her new coat". But what happens when we make this inference? It seems that the effect is to introduce a second **like** Role, giving:



{6}

Thus it appears that the introduction of a second **like** Role is what makes the use of 'the same colour' acceptable in sequence (4.10a,4.10e). But of course this ties in with what we suggested above — that more than one instance of the same Role requires us to use 'the same X' rather than 'the X'. And it looks as though, conversely, the presence of exactly one instance of a Role allows us, and indeed constrains us, to use 'the X' rather than 'the same X'.

We have presented a preliminary analysis of the distribution of 'the X' and 'the same X' (where X is a relational noun). In our account as it stands at present, a Role corresponds at least roughly to a relation expressed by a verb or a predicate nominal. We have reason to modify this notion of a Role shortly.

We will now consider some problematic examples for the analysis.

4.2.4 Some counterexamples

Our proposed analysis works for the examples given so far, but consider:

(4.19) a. Mary drove to London
b. Sally crashed the same car (a week later)

Note that (4.19a,4.19b) does **not** force us to make the inference that Mary crashed the car (although we are required to infer that Sally drove the car).[8] Yet our analysis predicts the necessity of this inference.

Consider also:

(4.20) a. Mary cleared the snow
b. Sally broke the same spade digging the garden later that year

It seems possible here to get a reading where Mary did not necessarily break the spade, whereas our analysis predicts that Mary broke it. We are reluctant to say that these examples are perfect (without the inferences), however. They feel like rather hard work to interpret. However, it is possible to construct other examples which are better. For example:

[8] Actually it appears that there is a certain intonation which does require us to infer that Mary crashed the car. But there is another intonation (with heavier stress on 'crashed') which does not require us to infer that Mary crashed. Our point is that (4.19b) does not *necessarily* require us to make this inference.

(4.21) a. Emily bought a new coat

b. Fiona dyed her scarf the same colour

does not require us to infer that Emily dyed *her* scarf.

Consider also:

(4.22) a. Jane scored a magnificent goal

b. John incurred a penalty at the same spot a few minutes later

This example sounds perfect. Here we have a Role which we could call 'spatial location'. Perhaps for some reason it is easier to make inferences regarding place Roles?

Consider also:

(4.23) a. Emily watched television this afternoon

b. Fiona recorded the same film

There is no need for us to infer here that Emily recorded the film as well as watching it. (In speech, 'recorded' might well receive intonational stress here in order to convey the contrast.) Compare:

(4.23) a. Emily watched television this afternoon

c. Fiona liked the same film

which forces us to infer that Emily liked the film. This is similar, of course, to (4.10a,4.10b) which we looked at earlier (repeated here as (4.24a,4.24b))

(4.24) a. Emily has a new coat

b. %Fiona likes the same colour

which, as we said earlier, requires us to infer that Emily likes the colour of her new coat.[9]

Our earlier explanation clearly needs refining. The examples above show that it is **not** necessary to have more than one Role of the same type in order for 'the same X' to be acceptable in this kind of example — or at least, not with the notion of Role that we have been using up to now. The examples involving the verb 'like' appear to behave differently from the rest. Let us look at which other verbs show the same kind of behaviour as 'like' in this respect.

(4.24) a. Emily has a new coat
b. Fiona loves/adores/admires the same colour
c. Fiona hates/dislikes/detests the same colour

We see from this that 'adores' and 'admires' appear to work the same way as 'likes'. 'Hates', 'dislikes' or 'detests' in (4.24c) sounds a little odd after (4.24a), but this may be because it is unexpected that Emily would dislike the colour of her new coat. If we try:

(4.26) a. Emily gave her coat to a jumble sale
b. Fiona hates/dislikes/detests the same colour

this sounds better (although still rather hard work to interpret), presumably because the fact that Emily gave her coat away is readily compatible with the fact that she disliked its colour.

Perhaps we can say that "attitude verbs" group together in forcing what we might call the **repeated Role inference**. We will pursue this idea further shortly. First,

---

[9] (4.24a,4.24b) seems to require the inference that Emily likes her coat in the same way that:

(4.25) a. Emily has a new coat
b. %Fiona likes the colour too

does. It would be interesting to investigate further the apparent parallelism between these examples, but we will not do this here.

let us turn to some non-relational uses of 'the same X' and see if we can observe similar effects with them.

4.2.5 Non-relational uses of 'the same'

We will now consider both discourse examples such as:

(4.27) a. Emily watched a film
b. Fiona recorded the same film

which constitute what Carlson (1987) calls sentence-external uses of 'the same'. We will look too at the corresponding sentence-internal uses such as:

(4.28) Emily watched and Fiona recorded the same film

Consider (4.27a,4.27b) first. We can interpret this sequence without being required to infer that Emily recorded the film. Note too that (4.28) sounds perfectly acceptable.

Now compare (4.29a,4.29b):

(4.29) a. Emily watched a film
b. Fiona liked the same film

Here, just as in the relational examples, we are required to make the inference that Emily liked the film. Once again, it is the example with 'likes' that behaves in this way. Note also that:

(4.30) *Emily watched and Fiona liked the same film sounds very odd, in contrast to (4.28). It is interesting, too, that we observe the same effect if we replace 'the same film' with the name of a particular film. If, for instance, we say:

(4.31) *Emily watched and Fiona liked 'Back to the Future'

this sounds odd in the same way as (4.30). This suggests that the effect we are observing is not restricted to 'the same' but applies more generally to coordination constructions. We will explore this further below.

Now consider what happens if we have "attitude" verbs in both sentences.

(4.32) a. Emily liked a film
b. Fiona hated the same film

This sequence sounds fine, and not at all contradictory, showing that we are not forced to infer that Emily hated the film. (4.33) also sounds fairly good, although arguably not perfect (but certainly much better than (4.30) above).

(4.33) Emily liked and Fiona hated the same film

We do not have an explanation for why (4.33) is not (according to some informants) completely acceptable. Intuitions appear to vary among native speakers here, in contrast to the other examples where intuitions are sharp and agree among different speakers. Interestingly, (4.33) sounds better if 'same' is removed, to give:

(4.34) Emily liked and Fiona hated the film

We will not attempt to explain why this is the case. Notice, too, that 'but' sounds better than 'and' in the above example:

(4.35) Emily liked but Fiona hated the film

Presumably this is because 'but' serves to convey the necessary contrast. We will not enter a discussion of the distribution of 'and' and 'but' here, however.

We can also construct single-subject examples which sound perfectly acceptable:

(4.36) Emily watched and recorded the same film

(4.37) Kate produced and directed the same film

But compare:

(4.38) *Emily watched and liked the same film

and:

(4.39) *Emily watched and hated the same film

We see that in all these cases, where both eventualities involve an **attitude** towards something:

1. Coordination is possible in examples like (4.33).
2. In the discourse examples we are **not** forced into the repeated-Role inference.

Similarly, if both eventualities involve what we might roughly characterize as some kind of **action**, then (1) and (2) hold in these cases too. It is in the "mixed" cases, where one eventuality is an **attitude** and the other an **action**, that things get interesting. In these cases, the single-sentence coordination becomes impossible, and in the discourse sequences we are forced into making a repeated-Role inference.

At this point we should note a slight complication in the case of coordination examples with a shared subject. Notice that:

(4.40) Emily watched and liked the film

is acceptable, in contrast to (4.38) — whereas in the other cases we have looked at, the 'same' examples and the coordination examples have behaved in the same way. We speculate that the 'and' in (4.40) conveys something in the way of temporal sequencing. It introduces a lack of "symmetry" in the sequence, making the order of the conjuncts matter. Notice that if we reverse the order of the conjuncts to give:

(4.41) *Emily liked and watched the film

the conjunction sounds very strange. We will not pursue this further, but in order to avoid this complication we will steer clear of single-subject examples in the discussion that follows.

The above observations suggest that some kind of generalisation of our earlier proposal is required. We proposed previously that the use of 'the same X' in a discourse sequence requires/conveys that we have *more than one instance of the same Role*. We employed a very narrow definition of Role, where the Role corresponds exactly to the verb. We now propose that what is needed is to generalise this notion of Role. From the examples we have studied so far, it looks as though we will need at least two Roles — one that we will provisionally call **object-of-attitude** and a second that we will call **object-of-action**. We will refer to these as generalised Roles (or GRs).

We are thus modifying our initial proposal as follows:

Modified proposal:

> 'The same X' conveys the presence of more than one instance of the GR in question. 'The X' conveys the presence of exactly one instance of the GR in question.

A possibility we should investigate is that the two Role types reflect simply the distinction between events and states. This might explain why 'like' (state) does not coordinate with 'watch' (event) in (4.38), for example. Consider however:

(4.42) a. Emily has/owns a new coat
b. Fiona likes the same coat

'Have', 'own' and 'like' are all generally considered to be stative. Yet:

(4.43) *Emily has and Fiona likes the same coat

sounds extremely odd.

(4.44) ?Emily owns and Fiona likes the same coat

is perhaps marginally better, but still sounds rather odd.

Thus we see that the state/event distinction does not seem to be what is relevant here. This leaves us with the task of deciding exactly which generalised Roles are needed in order to explain the data. We will give pointers rather than definite answers here. Further work is needed, involving the examination of constructions with a wide range of verbs.

We will settle here for the two generalised Roles, **object-of-attitude** and **object-of-action** so far proposed, and attempt to use them to express some of the non-relational examples in the EKN formalism used earlier.

We need to decide, too, what exactly a generalised Role should be, in formal terms. One possibility is to make it a relation between a situation (eventuality) and a participant of that eventuality. This would make a GR look rather like a thematic role in, for instance, (Dowty 1991). Indeed, we will examine the links between GRs and thematic roles shortly. However, before we proceed along these lines we need to consider a potential problem. We are thinking of each situation having exactly one GR of a particular type. But it is always possible to combine two situations to make a larger situation, and then there will only one Role. The answer to this is that Roles are associated with situations "as they are presented by the discourse". If the discourse presents two distinct situations then the discourse also presents two roles, and this is what counts, no matter how it is possible to consider the situations being merged to form larger ones.

Thus we propose to represent GRs as shown below, where a GR is a situation-theoretic relation holding between a situation (eventuality) and a participant of that eventuality. For example:

S
object-of-attitude(S,Y)

In the next section we will develop formal representations incorporating GRs.

4.2.6 Formal representations using generalised Roles

(4.45) a. Emily found an old coat

can be followed by either:

(4.45) b. Fiona liked the same coat

(which, as we have seen, forces the inference that Emily liked the coat)

or:

(4.45) c. Fiona threw away the same coat

(which does **not** force the inference that Emily threw away the coat).

The EKN representation for (4.45a) is:[10]

$r_1 \rightarrow S_1$, $r_2 \rightarrow X_1$, $r_3 \rightarrow Y_1$, $r_4 \rightarrow R_1$, $r_5 \rightarrow B_1$

S_1

find(X_1,Y_1)

R_1

named(X_1,'Emily')

B_1

coat(Y_1)
old(Y_1)

{7}

And for (4.45b), using the new notion of generalised Role:

$r_6 \rightarrow S_2$, $r_7 \rightarrow X_2$, $r_8 \rightarrow Y_2$, $r_9 \rightarrow R_2$

S_2

like(X_2,Y_2)

R_2

named(X_2,'Fiona')

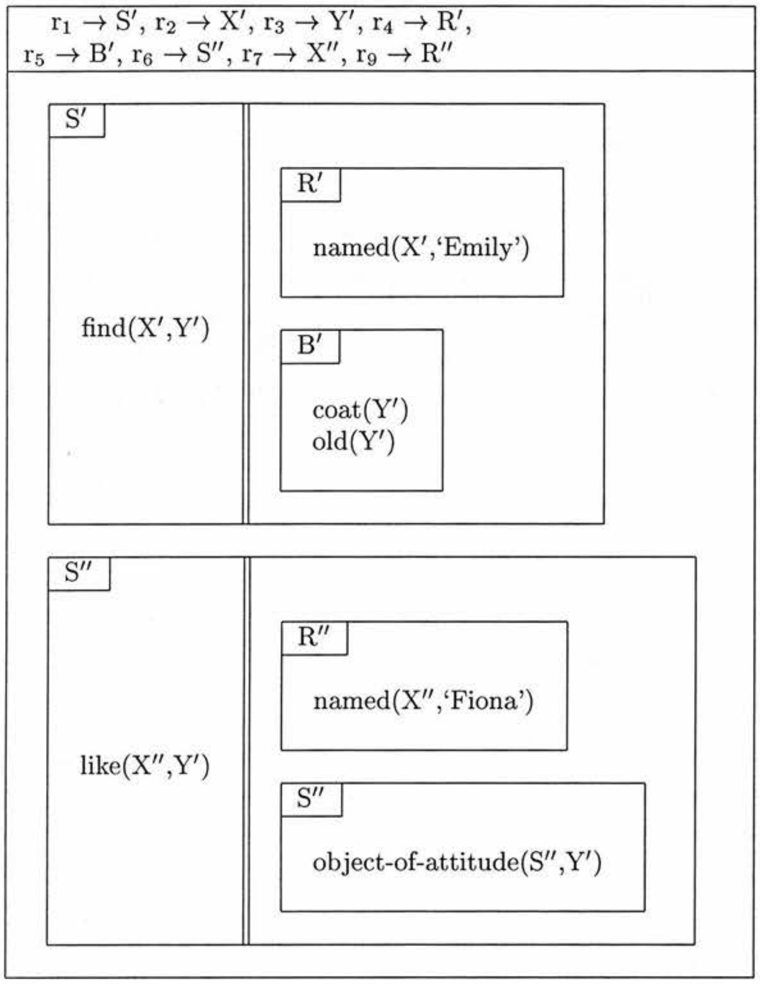
S_2

object-of-attitude(S_2, Y_2)

{8}

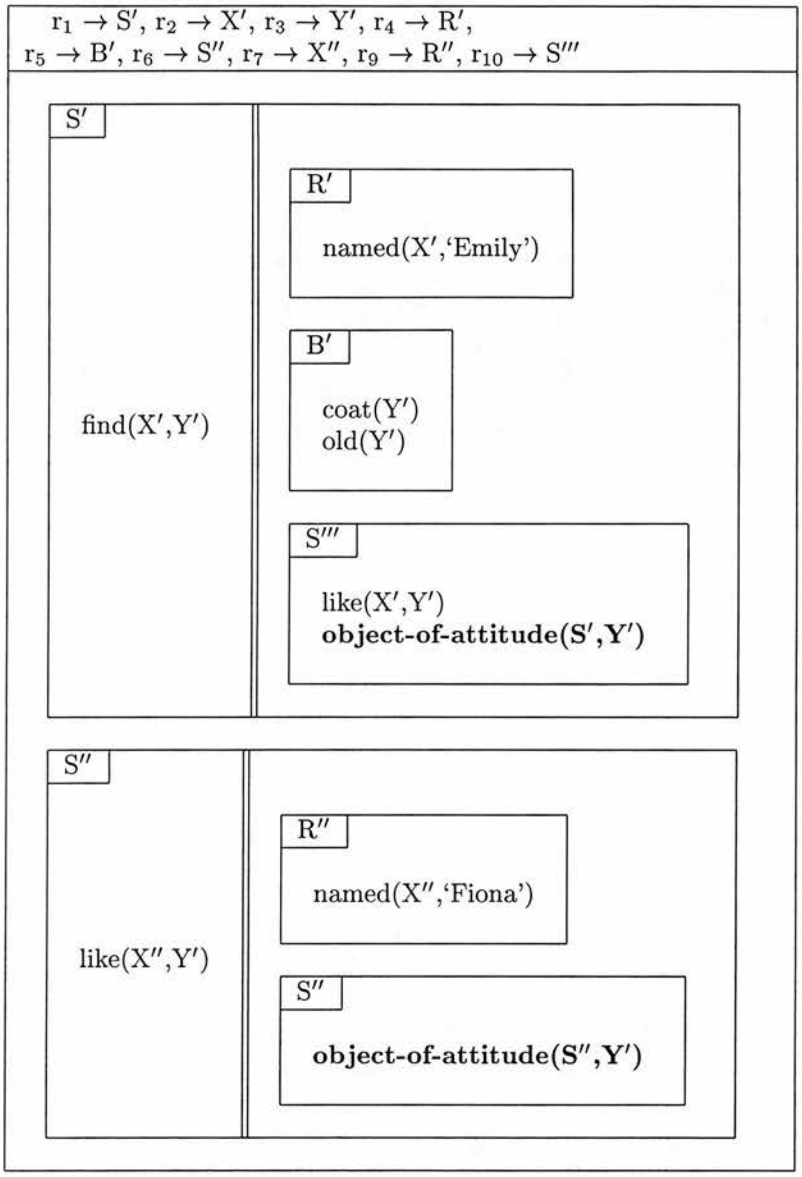
Merging the roles r_3 and r_8 and assigning new parameters gives us:

[10] We ignore tense in all the examples here.



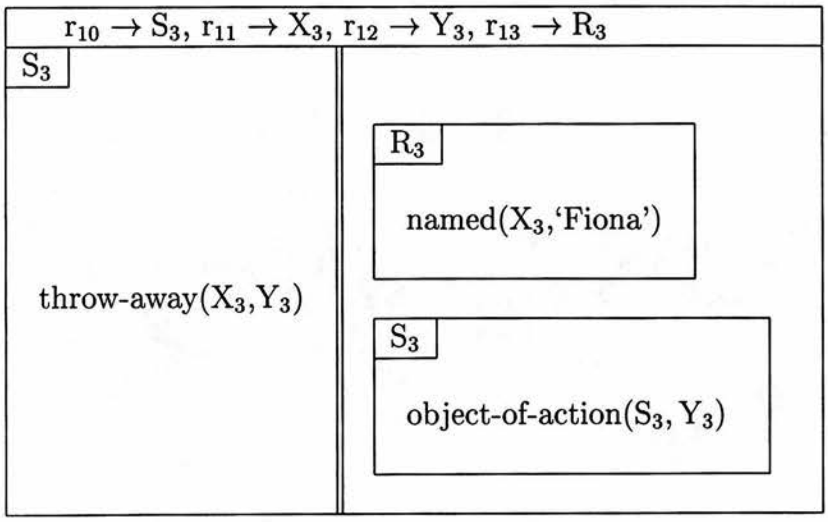
{9}

If we say, as proposed above, that 'the same X' forces there to be two instances of the same generalised Role, then this requires us to a infer an instance of the GR **object-of-attitude** in {7}. In order for this GR to be present we must make an inference regarding the attitude of Emily towards her coat. It seems reasonable to suppose that we make make the "simplest" inference needed to give the required **object-of-attitude** Role, i.e. the one where Emily's attitude is one of liking the coat. This gives us:



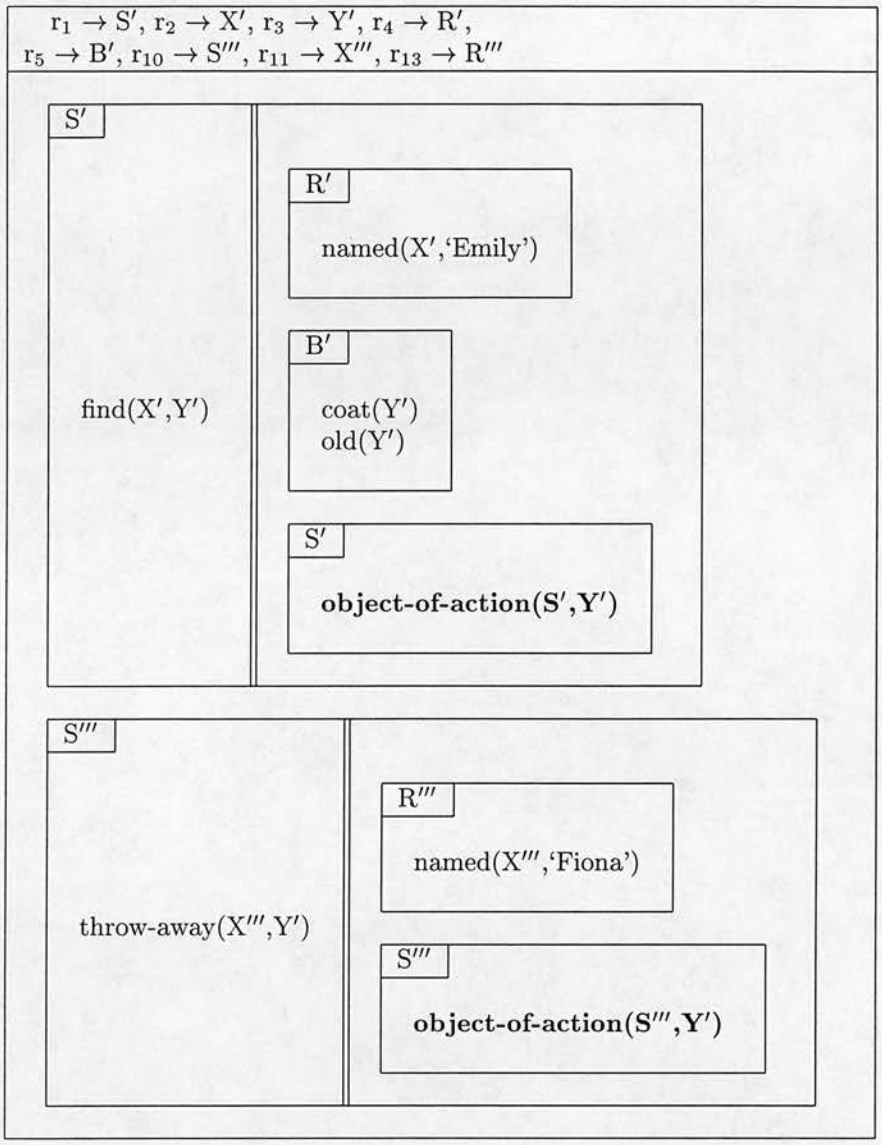
{10}

Now let us consider (4.45a,4.45c). For (4.45c) we get the representation:



{11}

Combining {3} with {1} by merging roles r_3 and r_{12} and assigning new parameters gives us:



{12}

The difference between the representation for (4.45a,4.45c) and the one for (4.45a,4.45b) is that in the present case we have two **object-of-action** Roles. The presence of two instances of the same generalised Role thus licenses 'the same' without requiring us to make any role-creating inferences.

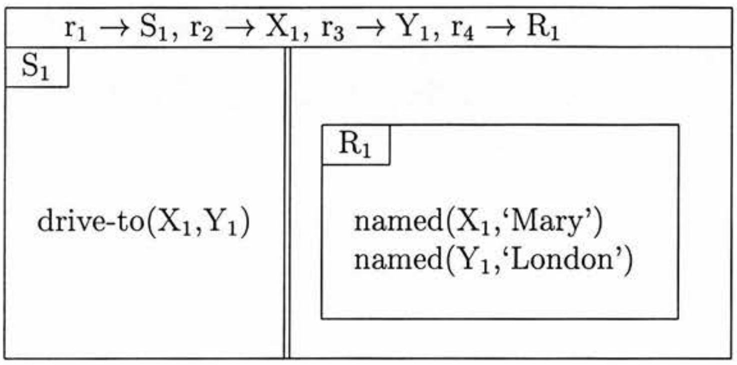
Now let us see how this works for the relational cases. We will apply it to two corresponding relational cases: (4.46a,4.46b), where we are required to make a role-creating inference, and (4.46a,4.46c), where no such inference is required. For convenience, we introduce the abbreviation GRCI here, standing for 'generalised-Role creating inference'.

(4.46) a. Mary drove to London

b. Sally liked the same car

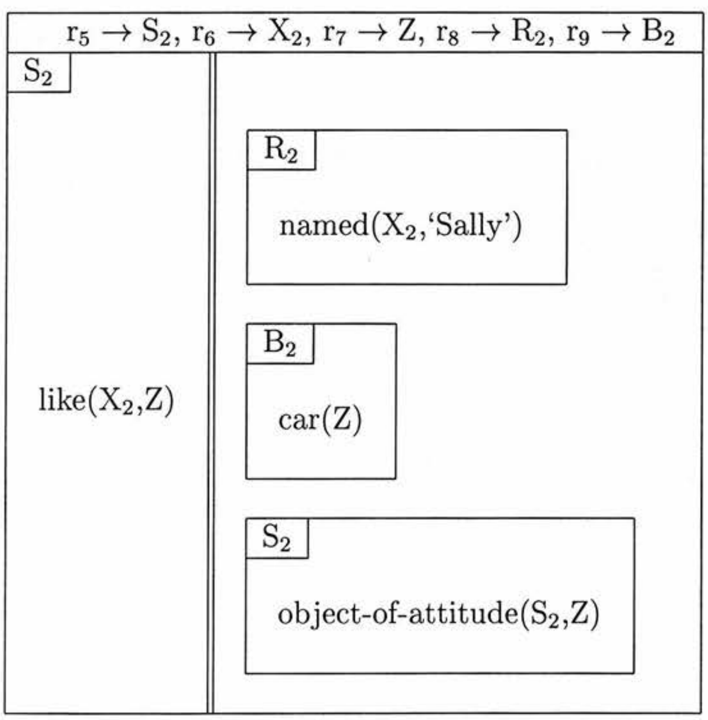
c. Sally crashed the same car

(4.46a) gives:



{13}

and (4.46b):



{14}

In order to combine {13} and {14}, we first need to add to {13} the accommodating inferences:

S_1
car-of(S_1,Z) object-of-action(S_1,Z)

giving:

$r_1 \rightarrow S_1$, $r_2 \rightarrow X_1$, $r_3 \rightarrow Y_1$, $r_4 \rightarrow R_1$, $r_{4b} \rightarrow Z_1$	
S_1 drive-to(X_1,Y_1)	R_1 named(X_1,'Mary') named(Y_1,'London') S_1 car-of(S_1,Z_1) object-of-action(S_1,Z_1)

{13′}

Then, combining {13′} and {14} by merging roles r_{4b} and r_7, we get:

$r_1 \rightarrow S'$, $r_2 \rightarrow X'$, $r_3 \rightarrow Y'$, $r_4 \rightarrow R'$, $r_{4b} \rightarrow Z'$,
$r_5 \rightarrow S''$, $r_6 \rightarrow X''$, $r_8 \rightarrow R''$

S'

drive-to(X',Y')

R'

named(X','Mary')
named(Y','London')

S'

car-of(S',Z')
object-of-action(S',Z')

S''

like(X'',Z')

R''

named(X'','Sally')

S''

object-of-attitude(S'',Z')

{15}

Note here that the generalised Roles are of different types. Hence, in order to license 'the same', we are required to infer that Mary liked the car, in order to supply a second **object-of-attitude** Role, corresponding to the second eventuality. Adding this inference gives us for the final representation:

$r_1 \rightarrow S'$, $r_2 \rightarrow X'$, $r_3 \rightarrow Y'$, $r_4 \rightarrow R'$, $r_{4b} \rightarrow Z'$,
$r_5 \rightarrow S''$, $r_6 \rightarrow X''$, $r_8 \rightarrow R''$, $r_9 \rightarrow B''$, $r_{10} \rightarrow S'''$

S′

drive-to(X′,Y′)

R′

named(X′,‘Mary’)
named(Y′,‘London’)

S′

car-of(S′,Z′)
object-of-action(S′,Z′)

S‴

like(X′,Z′)
object-of-attitude(S‴,Z′)

{15′}

S″

like(X″,Z′)

R″

named(X″,‘Sally’)

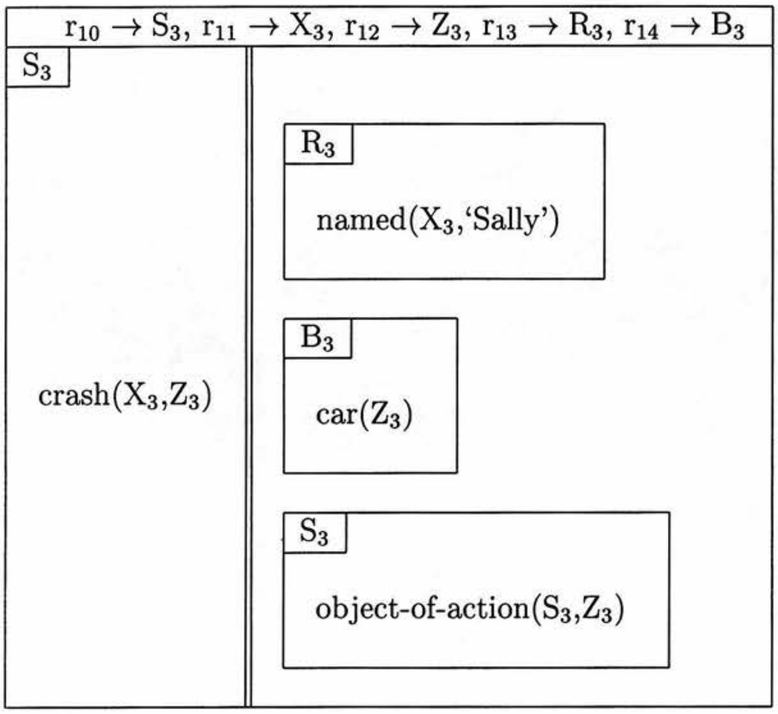
B″

car(Z′)

S″

object-of-attitude(S″,Z′)

Now let us look at the representation for (4.46c).



{16}

Combining this with {13} by merging roles r_{4b} and r_{12} and assigning new parameters gives us:

$r_1 \rightarrow S'$, $r_2 \rightarrow X'$, $r_3 \rightarrow Y'$, $r_4 \rightarrow R'$, $r_{4b} \rightarrow Z'$,
$r_{10} \rightarrow S'''$, $r_{11} \rightarrow X'''$, $r_{13} \rightarrow R'''$

S′

drive-to(X′,Y′)

R′

named(X′,‘Mary’)
named(Y′,‘London’)

S′

car-of(S′,Z′)
object-of-action(S′,Z′)

{17}

S‴

crash(X‴,Z′)

R‴

named(X‴,‘Sally’)

S‴

object-of-action(S‴,Z′)

Here, we have two **object-of-action** Roles, and so ‘the same’ is licensed without requiring any GRCIs to be made.

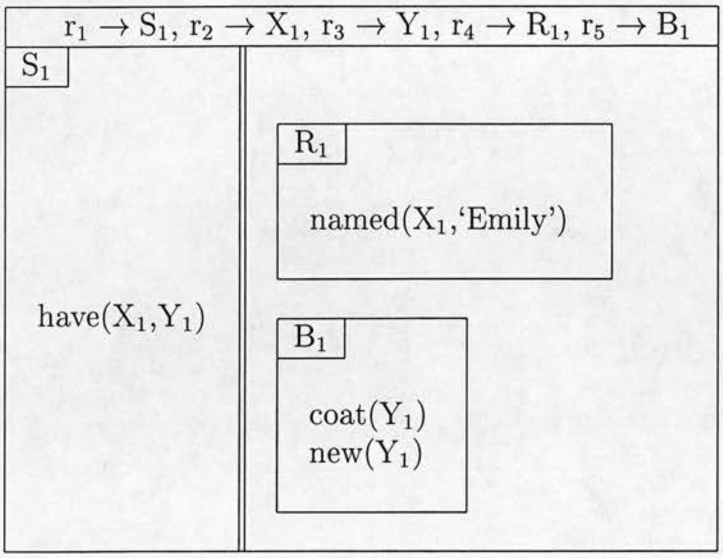
Finally, let us look at the relational example:

(4.47) a. Emily has a new coat
b. Fiona’s scarf is the same colour

which as we have seen does not require us to make a GRCI.[11]

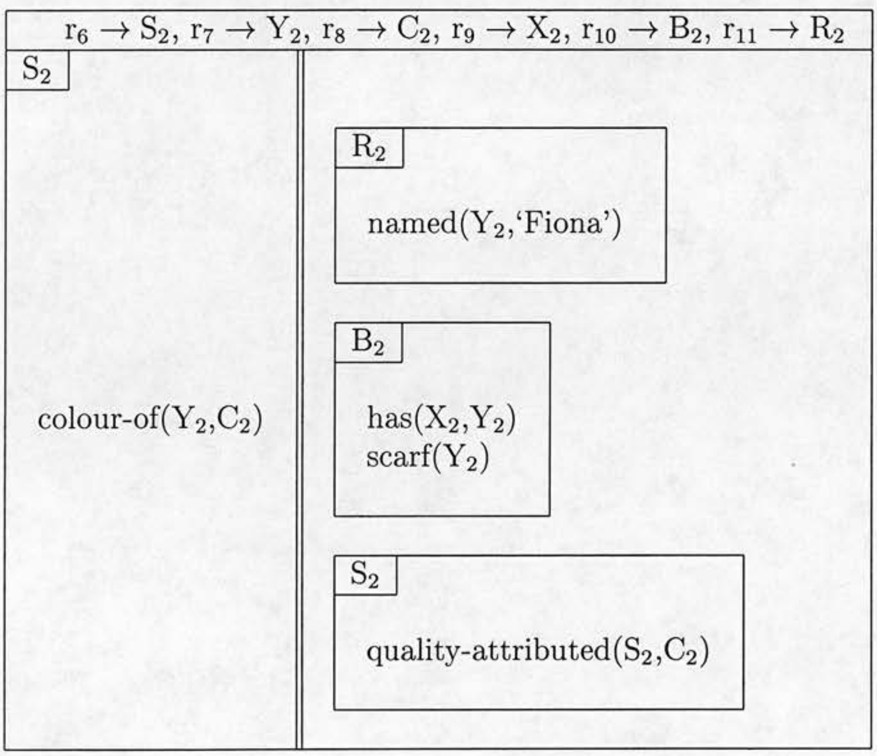
For (4.47a) we get the representation:

[11] Of course it does require us to make the **colour-of** inference.



{18}

and for (4.47b):



{19}

Here, we have introduced a new generalised Role we call **quality-attributed**. It appears that such a generalised Role is needed for attributes such as **colour-of**. Thus, so far we have found that we need at least three generalised Roles. It seems highly likely that additional ones will be required.

In order to combine {18} and {19}, we must add:

S_1
colour-of(Y_1,C_1)

to {18}, giving:

S_1
quality-attributed(Y_1,C_1)

for the generalised Role. This gives {18′}:

<table>
<tr><td colspan="2">$r_1 \rightarrow S_1$, $r_2 \rightarrow X_1$, $r_3 \rightarrow Y_1$, $r_4 \rightarrow R_1$, $r_5 \rightarrow B_1$, $r_{5b} \rightarrow C_1$</td></tr>
<tr><td>S_1

have(X_1,Y_1)</td><td>R_1
named(X_1,‘Emily’)

B_1
coat(Y_1)
new(Y_1)

S_1
colour-of(Y_1,C_1)
quality-attributed(S_1,C_1)</td></tr>
</table>

{18′}

Combining {18′} and {19} by merging roles r_{5b} and r_8 gives us:

$r_1 \rightarrow S'$, $r_2 \rightarrow X'$, $r_3 \rightarrow Y'$, $r_4 \rightarrow R'$, $r_5 \rightarrow B'$, $r_{5b} \rightarrow C$,
$r_6 \rightarrow S''$, $r_7 \rightarrow Y''$, $r_9 \rightarrow X''$, $r_{10} \rightarrow B''$, $r_{11} \rightarrow R''$,

S′

have(X′,Y′)

R′

named(X′,‘Emily’)

B′

coat(Y′)
new(Y′)

S′

colour-of(Y′,C)
quality-attributed(S′,C)

{20}

S″

colour-of(Y″,C)

R″

named(X″,‘Fiona’)

B″

have(X″,Y″)
scarf(Y″)

S″

quality-attributed(S″,C)

Thus we have two **quality-attributed** Roles — one corresponding to each sentence/eventuality — and the use of ‘the same’ is licensed without requiring any GRCIs to be made.

We have therefore demonstrated that by generalising the notion of Role we can explain the data that did not fit our original analysis of the relational cases. We have shown, too, that the revised account covers the non-relational and sentence-internal examples too.

Our proposal that 'the same X' requires/conveys two instances of the generalised Role in question ties in quite well with Carlson's suggestion (Carlson 1987) for non-relational, sentence-internal cases. He proposes that 'the same' requires the presence of more than one eventuality, where what is involved is a comparison between two "comparable eventualities" (p.545). However, he stops short of formalising what exactly he means by "comparable" or "paired" eventualities. The EKN framework appears to offer a convenient way of formalising this idea, which we unpack in terms of repetition of generalised Roles.

Moltmann, in her analysis of 'same'/'different' (Moltmann 1992), speaks of 'the same' conveying a comparison between certain participants in what she calls sub-events of a complex event. However, she does not consider the constraints on what type of sub-events may be conjoined in this way — which is the kind of thing we have tried to do.

Moltmann is interested in giving an account of quantificational cases like:

(4.48) All the students got the same answer

and:

(4.49) Many of the students went to see the same film

where it appears that the quantification is not just over individual students, but over subgroups of the total group. In order to deal with these examples, she proposes an analysis involving "parts" of the total group, where "part" is contextually defined. We are not particularly interested here in this aspect of her treatment, although we might well want to build something similar into our account in order to deal with such cases. More relevant to us here is the fact that she considers the events "under comparison" as being part of a total event which in (4.48) would be the event of all the students getting their answers. However, although Moltmann's account is based on the idea of events being part of a complex event, she does not consider any restrictions on which events may be combined to give a complex event. If we were to introduce some restrictions on which type of events could be combined, we could go some way towards explaining our repeated generalised Role requirement. For example, in the STDRT formalism we are using, we could presumably combine two events of type

get(students,answers)

to give a complex event. But suppose that we can only combine eventualities of certain types — for example, of a type where a quality is attributed to an object, or a type where some action is performed on an object. These correspond, of course, to the generalised Roles we identified earlier. And it appears that the same kind of restrictions apply to coordination — i.e., only events of the same "generalised type" may be coordinated, as we will see below.

4.3 Generalised Roles, Thematic Roles and Coordination

4.3.1 Introduction

The proposal we have made about generalised Roles also fits in with another proposal of Carlson's (Carlson 1984), where he suggests that we use thematic roles as the basis for individuating eventualities. The idea is that if the same thematic role is filled twice, then two eventualities must be present.

While our notion of eventuality may differ in some respects from Carlson's, it is nevertheless interesting to pursue this possible link. If we take our notion of generalised Role to correspond to Carlson's thematic role (type), we can explain his suggestion in (Carlson 1987, p.541) that 'the same' requires the presence of more than one eventuality. We can say that the reason 'the same' requires more than one eventuality is that 'the same' necessitates at least two instances of the same thematic role type. If we accept Carlson's (1984) suggestion that each (singular) eventuality has only one instance of each thematic role type, this in turn necessitates the presence of more than one eventuality.

Of course, the link between our account and Carlson's only works if our generalised Roles are seen to be equivalent to his notion of thematic role type. We mentioned earlier that it would be interesting to explore a possible correspondence here, and we will carry out a brief investigation on this below.

4.3.2 Thematic roles in the literature

The first point we should note is that there is no agreement in the literature about which thematic roles exist and how they should be characterised. Dowty (1991) explains how various authors have each proposed their own set of thematic roles in order to account for the data in which they are interested. He points out too that the notion of thematic role has been used very little in model-theoretic semantics. One semanticist who has studied thematic roles in detail over a number of years is Jackendoff (1983, 1987). However, although thematic roles (or 'thematic relations' as he calls them) play an important part in his semantics (where they are notions of conceptual structure), they are not defined in formal terms.

Thematic roles (or θ-roles) have also been used extensively in GB, where they have an argument-indexing function.

Dowty points out too that no-one, as far as he is aware, has ever attempted to produce a complete list of thematic roles. New ones are constantly being added to the list, and there is disagreement on the "semantic content" of even the most familiar roles, such as Theme and Patient (see Dowty 1991, p.548–9).

However, even though there is so little agreement on what thematic roles there are and how they should be defined, Dowty comments that many linguists seem to assume that linguistic theory should include a finite and fairly short set of them.

4.3.3 Dowty's proposal for thematic roles

Against this background, Dowty proposes (p.561) that, as a first step in moving forwards from this position, we should attempt to construct the best theoretical account we can for each domain separately. Such domains might include argument-selection (Dowty's own topic), acquisition, processing, and many others.

If our findings in the various domains converge on a single set of thematic roles, so much the better, and we can conclude that there is a single phenomenon involved in the various cases. If, on the other hand, the findings do not converge in this way, we may conclude that while there may be links between the phenomena in the different domains, we are still some way from discovering what these are.

Dowty focuses on argument selection and argues that in this domain only two thematic role types[12] are needed — which he calls **Proto-Agent** and **Proto-Patient**. These role types are prototypical in the sense that they are not discrete categories with strict defining criteria for membership, but cluster concepts rather like the prototypes of Rosch (1978). Dowty gives a list of entailments to be associated with each prototype, while admitting that these are preliminary lists and may need further refinement. (See Dowty 1991, p.572.)

These proto-roles work as follows where argument selection is concerned. The idea is that the argument for which the predicate entails the greatest number of Proto-Agent properties will be lexicalized as the subject of the predicate. Similarly, the argument having the greatest number of Proto-Patient properties will be lexicalized as the direct object. Dowty also considers what happens if two arguments of a relation have approximately equal numbers of Proto-Agent and Proto-Patient properties. In this case, either or both may be lexicalized as the subject, and similarly for the object. He also makes a proposal for three-place predicates, which we will not go into here. (See (Dowty 1991, p.576) for details.) He leaves open the possibility that there may be some kind of "weighting" of entailments as far as argument selection is concerned — i.e. the presence of a certain entailment may carry more weight than that of another.

Dowty argues that for the domain of argument-selection, only the thematic role types Proto-Agent and Proto-Patient are needed. He is not arguing that these role types are the only ones needed for other domains. As we mentioned above, he advocates deriving a set of necessary role types for each domain separately and

[12]Dowty distinguishes between what he calls 'individual thematic roles', which correspond to particular argument roles of particular verbs — e.g. the 'seen' role of 'see' — and what he calls 'thematic role types' which are generalisations across these — e.g. the traditional 'agent' and 'patient'. He refers to the latter strictly as 'thematic role types', although he sometimes abbreviates this to 'thematic roles'. In order to avoid confusion, we will call these 'thematic role types' in what follows.

then seeing how these compare across domains.

We will therefore follow Dowty's advice and investigate whether we can reformulate our generalised Role proposal in terms of thematic roles and, if we can, which thematic role types we will need. We will also adopt Dowty's idea of trying to express thematic role types in terms of sets of entailments.

4.3.4 Generalised Roles and entailments

We found that the following generalised Roles were needed for the examples considered so far (recall that we also made it clear that this list was not intended to be exhaustive).

1. Object-of-action
2. Object-of-attitude
3. Quality-attributed[13]

Let us first investigate whether (1) appears to correspond to Dowty's cluster of properties for the Proto-Patient role type. These were:

(a) Undergoes change of state
(b) Incremental theme
(c) Causally affected by another participant
(d) Stationary relevant to movement of another participant
((e) Does not exist independently of the event, or not at all).

The reader is referred to Dowty (1991), p.572, where Dowty explains the meaning of these properties in more detail. He places (e) in parentheses because of his uncertainty about whether this property should be associated not with thematic role type but with what he calls "the discourse associations of subjecthood". We will not worry about this distinction here, and will treat (e) as equal in status

[13]It is important to note that (3) would not correspond to a thematic role according to the standard notion of thematic role.

with the other properties in our investigation, which is only intended to be a preliminary one.

A final point we should note is that Dowty emphasises that these properties are associated not with the object "in itself" but with the object as it relates to the event or state denoted by the verb. Thus an object is an incremental theme (for example) with respect to a particular event in which it participates. It is important to bear this in mind when deciding upon entailments.

Now let us look at one of our examples where we proposed that two instances of the generalised Role **object-of-action** were involved. An example of this kind was (4.45a,4.45c), reprinted here as (4.50a,4.50b).

(4.50) a. Emily found an old coat
b. Fiona threw away the same coat

Working through the list of Proto-Patient properties for the objects in (4.50a) and (4.50b), we get the following results:

Proto-Patient property	4.50a	4.50b
(a) change-of-state	yes	yes
(b) incremental theme	no	no
(c) causally affected	yes	yes
(d) stationary (rel.)	yes	yes
(e) no indep. existence	no	no

It is not entirely straightforward to decide whether or not the objects of 'find' and 'throw away' undergo changes of state. If we allow a change of position to be a change of state, as Dowty does, then it seems clear that the object of 'throw away' undergoes a change of state. However, presumably finding something does not entail that the position of the object changes — this is only the case if the object is picked up and taken home, for example. We might argue that the context provided by (4.50a,4.50b) forces us to infer that Emily did something like take the coat home, however. If we do make this inference, then it seems reasonable to say that the coat undergoes a change of state in each case. However, this example does highlight the need to define very carefully what we mean by properties such as 'change of state' in the sets of entailments we use. There may also be a problem in defining exactly what is meant by (d) ('stationary relative to the movement of another participant').

The fact that neither comes out "totally Proto-Patient" does not matter, because, as we explained above, Dowty's sets of entailments do not provide sets of necessary conditions for patienthood. What is interesting is that both examples say yes to exactly the same subset of the set of entailments. This suggests that we may be on the right lines in trying to account for our 'same' data in terms of entailments. Perhaps the entailments are more important than the generalised Roles (or thematic role types) themselves. Dowty suggests this himself, and points out that by accounting for the data in terms of entailments we are not simply replacing one theoretical construct by another. What is important about entailments, he argues, is that they are much more basic to human conceptualisation than the notion of thematic role type (it is hard to argue with this!). He points out that the concept of "volition" (one of the properties associated with the Proto-Agent role type) is something which may be argued about in a court of law. We agree that it is much harder to envisage a jury being asked to decide on whether the defendant was a Proto-Agent. Having said this, we must also point out that some of the properties in Dowty's lists of entailments appear much more natural to human conceptualisation than others. (d), for example, does not strike us as a particularly intuitive concept. But of course Dowty does not claim to have provided the definitive set of proto-properties, and perhaps this is simply motivation for trying to improve on the classification.

Let us look now at the entailments for another example involving two instances of the generalised role type **object-of-action**, (4.19a,4.19b), repeated here as (4.51a,4.51b).

(4.51) a. Mary drove to London
b. Sally crashed the same car

There is a slight complication in working out the entailments for the object argument of (4.51a) here, because the direct object of the driving event is not explicitly realised. No vehicle is mentioned in (4.51a), and the hearer must infer that there is a car that Mary drove to London in order to interpret (4.51a,4.51b). If we make this inference, we can work out the entailments for the implicit direct object, as required.

The entailments are as follows:

Proto-Patient property	4.51a	4.51b
(a) change-of-state	yes[14]	yes
(b) incremental theme	no	no
(c) causally affected	yes	yes
(d) stationary (rel.)	yes	yes
(e) no indep. existence	no	no

Once again, the subset of entailments is the same in each case (as long as we are prepared to accept that driving a car changes its state).

Now let us investigated the entailments for 'watch'/'record' in (4.27a,4.27b), repeated here as (4.52a,4.52b).

(4.52) a. Emily watched a film
b. Fiona recorded the same film

Proto-Patient property	4.52a	4.52b
(a) change-of-state	no[15]	no[15]
(b) incremental theme	no	no
(c) causally affected	no	no
(d) stationary (rel.)	yes	yes
(e) no indep. existence	no	no

[14]As long as we are prepared to accept change of position as a change of state, as we did above. Of course it may be argued that the act of driving a car changes its state anyway (e.g. wears down the brakes, the engine, etc.) but this seems a very different notion of change of state from the one in (4.51b), for example. There are clearly issues which need to be addressed more closely here.

[15]Once again, the issue arises of what exactly is involved in a change of state. However, it seems reasonably intuitive in this case to say that the film does not undergo a change in state

Once again, we have a notable correspondence of entailments between the two examples. The three examples considered so far are all ones where 'the same X' is licensed without making a generalised Role creating inference (GRCI). Now let us try an example where where 'the same X' is not licensed without a GRCI. An example we considered of this type was (4.45a,4.45b), repeated here as (4.53a,4.53b).

(4.53) a. Emily found an old coat

b. Fiona liked the same coat

Let's examine the entailments for the object arguments here.

Proto-Patient property	4.53a	4.53b
(a) change-of-state	yes[15]	no
(b) incremental theme	no	no
(c) causally affected	yes	no
(d) stationary (rel.)	yes	yes
(e) no indep. existence	no	no

Here, we see that the set of entailments is not identical in each case. The object argument of 'find' may be said to be causally affected by the eventuality in question, whereas the object of 'like' is not.[16]

Now let us turn to some **object-of-attitude** examples. One example we gave where 'the same' is acceptable without a GRCI is (4.32a,4.32b), repeated here as (4.54a,4.54b).

when it is watched. Perhaps this depends on whether we interpret a film to as a particular copy of a film (unlikely in this case) or whether the notion of a film generalises over particular copies of that film (which seems reasonable here). If the reference to a film abstracts away from particular copies of that film then it appears correct to say that watching a film does not change its state.

[16]This seems intuitively correct, although of course we are not using any formal definition of 'causally affected'. Dowty does not offer formal definitions of these properties and indeed it appears that it would be almost impossible to do so. These kinds of properties, it appears, are no easier to tie down precisely than notions like 'agent' and 'patient'. One advantage over the former is, however, as we pointed out earlier, that they have strong intuitive content.

(4.54) a. Emily liked a film

b. Fiona hated the same film

The entailments for the object arguments here are as follows:

Proto-Patient property	4.54a	4.54b
(a) change-of-state	no	no
(b) incremental theme	no	no
(c) causally affected	no	no
(d) stationary (rel.)	yes	yes
(e) no indep. existence	no	no

Once again, the set of entailments in each case is the same.

So far, we have seen that our examples where 'the same' was licensed without a GRCI correspond exactly to those examples where the subset of Dowty's set of Proto-Patient entailments that are associated with the object argument are the same in each case. The examples where 'the same' is only acceptable by making a GRCI correspond to the cases where the subset of Proto-Patient entailments is *not* the same in each case.

Thus we can provisionally conclude at this point that the distribution of 'the same X' (where X is an object argument) seems to be closely related to Dowty's proposed entailments, and that using entailments appears to be a promising way forward in accounting for this data. We are not, however, convinced that Dowty's set of Proto-Patient entailments are exactly the ones we need. For example, as discussed above, the notions 'undergoes change of state' is particularly hard to define. We may well find that we need to refine Dowty's sets of entailments as further work is done on this.

Let us now consider an example where it becomes necessary to introduce a property that is not contained in the set of entailments for Proto-Patient.

Consider, for example:

(4.55) a. Emily owned a hamster

b. Fiona disliked the same hamster

In order to interpret this sequence, we are forced to make the GRCI that Emily disliked her own hamster. This makes the sequence sound rather odd, because it is unexpected for a young girl to dislike her pet hamster. Thus we might, on the basis of our findings so far, expect the set of entailed properties for the object argument to be different for 'own' and 'dislike'. Let us see if this is the case.

Proto-Patient property	4.55a	4.55b
(a) change-of-state	no	no
(b) incremental theme	no	no
(c) causally affected	no[17]	no
(d) stationary (rel.)	yes	yes
(e) no indep. existence	no	no

Thus we see that[18] the sets of entailments here are identical. This is interesting in that it is the first case we have come across where a GRCI is required even though the set of entailments are the same. If we are to pursue our explanation in terms of entailments, it looks as though we will need to modify Dowty's list in order to reflect some distinction between 'own' and 'dislike' in terms of what is entailed about their object arguments.

What is the intuitive distinction? The one that springs readily to mind is that a disliking is an "experience" or "attitude" and an owning is neither of these. Indeed, we reflected this by introducing our **object-of-attitude** Role earlier.

One way round this would be to introduce another Proto-Role in addition to Dowty's Proto-Agent and Proto-Patient. This new Proto-Role would involve some entailment like "stimulates emotional response in another participant".

It is interesting to note that Dowty's set of entailments for the Proto-Agent Role include a property rather like this. We give his set of Proto-Agent properties below:

[17]Is an object causally affected by virtue of being owned? We are inclined to say "no", although this may be debatable. Once again, the question hinges on what exactly is meant by 'causally affected'.

[18]If we ignore the uncertainty about causal affectedness for (4.55a)

(a) Volitional involvement in the event or state
(b) Sentience (and/or perception)
(c) Causing an event or change of state in another participant
(d) Movement (relative to the position of another participant)
((e) Exists independently of the event named by the verb)

(Dowty 1991, p.572).

Thus (c) is similar to our new property. However, we would be reluctant to assign the object argument of 'dislike' to the role Proto-Agent by virtue of this property alone, as it has none of the other entailments in Dowty's Proto-Agent list. It seems much more reasonable to introduce a new Proto-Role as we suggested above. One possibility is that this might correspond to 'Theme' in those thematic role systems which assign Experiencer/Theme to the arguments of certain verbs. However, as Dowty points out, 'Theme' has been used in different ways by different authors, and for this reason we will avoid it.

Once again, further work is needed to decide exactly what Roles are needed for our purposes. Once this is done, it will be possible to look at the sets of thematic roles that have been motivated for other domains, and make comparisons. It seems entirely possible that sets of entailments will ultimately prove more useful in explaining the data on 'the same X' than the notion of generalised Role.

We should say something here about locatives, such as the example (4.22a,4.22b), discussed earlier and repeated here as (4.56a,4.56b).

(4.56) a. Jane scored a magnificent goal
b. John incurred a penalty at the same spot a few minutes later

We saw that this example was acceptable without a GRCI, and explained this in terms of the same generalised Role 'location-of' being referred to in each case. But Dowty does not regard spatial and temporal modifiers (or indeed adjuncts of any kind) as thematic roles. It appears that we need to part company from him here, too, if we are to explain the above example, and allow a Role corresponding to 'event-location' or something similar. We will consider time Roles in the next section.

Before we conclude this discussion, let us consider some interesting single-sentence examples. We begin with:

(4.57) John likes and fears the same woman

We can explain the acceptability of (4.57) in terms of 'likes' and 'fears' having the same subset of Proto-Patient entailments for the object argument (with the addition of the property 'stimulus of emotional response in another participant'). Now compare:

(4.58) *John likes and amuses the same woman

which is very hard work to interpret (and appears to cause the hearer to experience mental contortions in trying to understand it). The reason for the difficulty, intuitively, is that John is the "experiencer" in the first conjunct and the woman is the experiencer in the second conjunct. Or, in the terms we have been using above, the woman is the stimulus of the response in the first conjunct, and John is the stimulus in the second. We can then say that this "role-switching" is the reason that for lack of acceptability of (4.58).[19]

But note that the presence of the passive allows us to make precisely this kind of switch.

(4.60) John likes and is despised by the same woman

This suggests that the passive allows us to convey precisely the kind of role-reversal that sounded so strange in the non-passive example (4.58). This appears to be an interesting topic for further study, but we will not pursue it here.

---

[19] The discourse example

(4.59) a. John likes Mary

b. Fred amuses the same woman

also sounds extremely odd, for the same reason.

4.3.5 'The same X' and coordination

We pointed out earlier that the discourse examples involving 'the X' and 'the same X' appear to parallel very closely the single-sentence examples like:

(4.61) Emily watched and Fiona recorded the same film

and that these are closely related to the corresponding "coordination" examples without 'the same', such as:

(4.62) Emily watched and Fiona recorded the film

in terms of what we might call 'compatibility of conjuncts'. That is, the examples involving 'the same' parallel closely the more general examples involving object-NP coordination. This suggests that we should look at the literature concerning semantic constraints on conjunct coordination. We give a very brief summary of this below.

Although a great deal of work has been done on **syntactic** constraints on coordination, it appears that relatively little progress has been made concerning semantic constraints. It was pointed out by Lakoff (1971) that such constraints exist, and one constraint that she suggested was that events coordinate with events and states with states but cross-coordination is not allowed. Schachter (1977) also gave evidence that semantic constraints on coordination are needed in addition to syntactic ones. He proposed that what is required for coordination is "identity of semantic function", but he did not say much about what this identity involves. Lang (1984) developed the notion of "common integrator" which involves finding the material that is common to both conjuncts, but he did not specify precisely what the conjuncts must have in common in order to coordinate. Hudson (1988) admits that the role of semantic factors in coordination is a serious research problem for all theories of coordination.

The idea has been around for some time that thematic roles/relations may be involved in the semantic constraints on coordination. It can be traced back at least as far as Fillmore (1968), who drew attention to examples like:

(4.63) *John and a hammer broke the window

where the unacceptability of the NP conjunction is explained by the fact that the NP 'John' is the Agent whereas the NP 'a hammer' is the Instrument. (Fillmore uses the term 'case' rather than 'thematic role/relation', but the notions are closely related.)

The idea that thematic roles are involved in constraints on coordination was explored further recently by Johannessen (1990). She proposed that thematic role constraints may be involved in determining the possibility of coordination and ruling out certain syntactically-allowable conjunctions. In fact, she followed Dowty in expressing thematic roles as prototypical sets of entailments, as we did earlier. She suggested that coordination requires a "unifiable set of entailments" across the conjuncts. There is an interesting link here with our work on 'the same' described above. It is worth noting, too, that Johannessen found that a larger set of roles were required than Dowty's Proto-Agent and Proto-Patient, which accords with our results.

This supports the suggestion that the same phenomenon is involved in the coordination examples and in our examples involving 'the same'. More work is needed to follow up this connection further, and, as we noted above, to decide exactly which sets of entailments are required.

4.3.6 Conclusion

We have investigated the link between our proposed generalised Roles and the notion of thematic role in the literature. Using Dowty's notion of Proto-Role, we showed that our findings may be explained at least in part in terms of Dowty's sets of entailments. We also investigated the link between our data on 'the same X' and the related coordination examples. In particular, we considered the connection between our notion of generalised Role, the notion of thematic role and Johannessen's suggestion that semantic constraints on coordination can be expressed in terms of Proto-Roles and entailments. Further work is needed to investigate this connection further and to decide which Generalised Roles are required and what is the best way to characterise them in terms of prototypical sets of entailments.

4.4 Time Roles and Discourse Backgrounding

4.4.1 Introduction

We now turn to some examples involving the temporal expressions 'at the time' and 'at the same time'. We will show how our analysis of 'the X' and 'the same X' can be applied to temporal examples. This will involve us in considering the nature of time Roles, and our conclusions will lead us, in turn, to a means of formalising the notion of **backgrounding** in discourse.

In our analysis of sentence-final 'then' in Chapter 2 we briefly considered sentence-final 'at the time' and 'at the same time', and pointed out that 'at the time' behaves in a roughly similar way to the PART-OF (or Role) use of 'then'. Here, we will use the account of 'the X' and 'the same X' developed in the current chapter to give a more complete analysis of 'at the time' and 'at the same time'.

First, let us recap on what we discovered about sentence-final 'at the time' and 'at the same time' in Chapter 2. First, we saw that a sequence of two sentences where the second ends in 'at the time' requires that the second sentence is either a stative or a progressive. For example:

(4.64) a. Emily climbed Ben Nevis
b. *Fiona climbed Snowdon at the time
c. Fiona was a young girl at the time
d. Fiona was climbing Snowdon at the time

(4.64a,4.64b), where the second sentence is neither stative nor progressive, is not acceptable. By contrast, (4.64a,4.64c) and (4.64a,4.64d) are both acceptable. We saw that 'at the time' behaves like the PART-OF use of sentence-final 'then' in these examples. However, we also observed that 'at the time' differs from PART-OF 'then'[20] in that 'then' can also be used following an elaboration, as in

[20] From now on we will drop 'sentence-final' and assume this to be understood.

(4.65a,4.65b), while it is not possible to use 'at the time' to follow an elaboration, as in (4.65a,4.65c).

(4.65) a. Emily climbed Ben Nevis
b. She saw an eagle then
c. *She saw an eagle at the time

We saw that 'at the same time', on the other hand, requires that if the first sentence describes an event then the second must also describe an event as opposed to a state.[21] Thus (4.66a,4.66b) is acceptable and (4.66a,4.66c) is not.

(4.66) a. Emily climbed Ben Nevis
b. Fiona climbed Snowdon at the same time
c. *Fiona was a girl at the same time

We noted too that 'at the same time' is not acceptable for a sequence involving an elaboration. Thus (4.67a,4.67b) sounds strange, apparently forcing us to see the events as somehow "separate" or "distinct".

(4.67) a. Emily climbed Ben Nevis
b. ??She saw an eagle at the same time

Note that this is the case even when the second sentence involves a redescription of the same event (so that the two event times are identical):

(4.68) a. Emily climbed Ben Nevis
b. ??She achieved her ambition at the same time

[21]We will discuss a complication of this where progressives are concerned, below.

This again sounds odd, apparently conveying that the events described by the two sentences were unconnected except by their coincidence of event times.

We provisionally concluded in Chapter 2 that 'at the same time' requires that the second eventuality is not PART-OF the first. (4.68a,4.68b) shows that we must add to this the requirement that the second event is not a redescription of the first. Thus it appears that 'at the same time' requires that the two eventualities are seen as "distinct".

Thus we have PART-OF 'then', which requires that the second eventuality is part-of the second, either by virtue of **elaboration** or **backgrounding** (see Chapter 2). We have 'at the time' which requires that the second eventuality is part-of the first, but in this case the relation must be one of backgrounding but *not* one of elaboration. Finally, we have 'at the same time' which requires that the second eventuality is distinct from the first.

We would like to be able to give an explanation of why the above distribution obtains. Before we attempt to do so, let us note an interesting observation regarding 'at the same time' and 'at the time' when the second sentence is a progressive.

(4.69) a. Emily climbed Ben Nevis
b. Fiona was climbing Ben Nevis at the time
c. Fiona was climbing Ben Nevis at the same time

Thus we see that either 'at the same time' or 'at the time' is acceptable if the second sentence is a progressive. This contrasts with the case where the second sentence is a (lexical) stative, where we saw in (4.66a,4.66c) that 'at the same time' is not acceptable. This is an interesting difference between progressives and (lexical) statives, for which we will propose an explanation below. It will lead us to challenge the widely accepted idea that the progressive should be seen as a stativiser.

Let us take the following as the basic set of sequences that we will attempt to explain. (We will also account for the further restrictions on 'at the time' and 'at the same time' involving elaborations, discussed above.) In the examples below, (4.70a) is followed by one or other of (4.70b–4.70g).

(4.70) a. Emily climbed Ben Nevis

b. *Fiona climbed Snowdon at the time

c. Fiona climbed Snowdon at the same time

d. Fiona was a girl at the time

e. *Fiona was a girl at the same time

f. Fiona was climbing Snowdon at the time

g. Fiona was climbing Snowdon at the same time

4.4.2 Times as generalised Roles?

Can we explain the observations for 'at the time' and 'at the same time' using the notion developed earlier in this chapter of **generalised Role**? Recall that we proposed that 'the same X' requires/conveys that we have more than one instance of the same generalised Role, and that 'the X' requires/conveys that we have exactly one instance of the generalised Role in question. This leads us to ask whether we can see time Roles in this way. Can we explain the distribution of 'at the time' and 'at the same time' by (a) viewing time as a generalised Role and then (b) showing that only one such Role is present in the 'at the time' cases while two time Roles are present in the 'at the same time' cases'?

First, is it possible to see the times we associate with eventualities as generalised Roles? There seems to be no problem with doing this. Recall that in Chapter 3 we proposed that if:

$$\begin{array}{|c|}\hline \mathrm{S} \\ \hline \sigma(\mathrm{T}) \\ \hline \end{array} \quad \text{is true}$$

and:

$$\begin{array}{|c|}\hline \mathrm{S},\sigma(\mathrm{T}) \\ \hline \mathrm{KEY} \\ \hline \end{array} \quad \text{is true}$$

then we can say that:

S,T	
TIME-OF	is true,

meaning that T is the "eventuality time" of S, which we can think of as the duration of the eventuality S.

This allows us to see T as the TIME-OF Role of S. Let us assume that such TIME-OF Roles of eventualities are generalised Roles, and see how far we get with this.

We begin by considering (4.70a,4.70b) and (4.70a,4.70c). Firstly, why should (4.70a,4.70b) be unacceptable? The explanation that suggests itself is that 'at the time' is unacceptable because more than one TIME-OF Role is present, requiring us to use 'at the same time' as in (4.70a,4.70c). Let us construct the EKN representation for this sequence to investigate this.

We can represent (4.70a) in EKN as follows:

$r_1 \rightarrow S_1,\ r_2 \rightarrow X_1,\ r_3 \rightarrow Y_1,\ r_4 \rightarrow R_1,\ r_{4b} \rightarrow T_1$

S_1: $\mathrm{climb}(X_1, Y_1, T_1)$	R_1: named(X_1,'Emily') named(Y_1,'Ben Nevis') $S_1, \mathrm{climb}(X_1, Y_1, T_1)$: KEY S_1, T_1: TIME-OF

{21}

It could be argued that as no time is mentioned in (4.70a), the role r_{4b} is superfluous here. If we treat these examples as parallel to the non-temporal ones, we would not introduce TIME-OF here, but would delay its introduction until the processing of 'at the time' in (4.70b). It would make no difference to our account if we were to follow this procedure. However, in the interests of simplicity we will introduce the TIME-OF Role in the initial processing of (4.70a).

We can represent (4.70b) as:

$\mathrm{r}_5 \to \mathrm{S}_2,\ \mathrm{r}_6 \to \mathrm{X}_2,\ \mathrm{r}_7 \to \mathrm{Y}_2,\ \mathrm{r}_8 \to \mathrm{R}_2,\ \mathrm{r}_9 \to \mathrm{T}_2$	
$\boxed{\mathrm{S}_2}$	$\boxed{\mathrm{R}_2}$ named(X_2,'Fiona') named(Y_2,'Snowdon')
climb($\mathrm{X}_2, \mathrm{Y}_2, \mathrm{T}_2$)	$\boxed{\mathrm{S}_2, \mathrm{climb}(\mathrm{X}_2, \mathrm{Y}_2, \mathrm{T}_2)}$ KEY
	$\boxed{\mathrm{S}_2, \mathrm{T}_2}$ TIME-OF

{22}

Now we need to combine {21} and {22} in such a way as to express that the times for each eventuality are identical. We do this by merging roles r_{4b} and r_9. When we do so and assign new parameters we get:

$r_1 \rightarrow S'$, $r_2 \rightarrow X'$, $r_3 \rightarrow Y'$, $r_4 \rightarrow R'$, $r_{4b} \rightarrow T'$,
$r_5 \rightarrow S''$, $r_6 \rightarrow X''$, $r_7 \rightarrow Y''$, $r_8 \rightarrow R''$

S′

climb(X′, Y′, T′)

R′

named(X′,'Emily')
named(Y′,'Ben Nevis')

S′, climb(X′, Y′, T′)

KEY

S′, T′

TIME-OF

S″

climb(X″, Y″, T′)

R″

named(X″,'Fiona')
named(Y″,'Snowdon')

S″, climb(X″, Y″, T′)

KEY

S″, T′

TIME-OF

{23}

Thus the representation captures the fact that there are two TIME-OF Roles in the combined representation, which allows us to explain why 'at the time' is unacceptable here, and why 'at the same time', as in (4.70a,4.70c), must be used.

Thus what we have said so far amounts to the proposal that each eventuality described by the discourse has its own TIME-OF Role. We will modify this to some extent when we consider the examples with progressives and statives.

It may be thought that associating each situation with TIME-OF Role in this way may lead to problems in that two situations could be put together to form a single situation which would presumably have only one TIME-OF Role. But what is important here are the situations (and associated TIME-OF Roles) that are actually introduced by the discourse. Ways that these situations might be merged "in the real world" are in a sense irrelevant to the structure of the discourse.

What explanation can we give for (4.70a,4.70d) and (4.70a,4.70e), where things are reversed and 'at the time' is acceptable while 'at the same time' is not? An obvious difference here is that 'Fiona was a young girl' describes a state. The sequence (4.70a,4.70d) thus describes an (accomplishment) event and a state.

Let us consider for a moment the intuitive meaning of (4.70a,4.70d). The sequence conveys that at the time that Emily made her climb, Fiona was a girl, and that Fiona was a girl for some time both before and after the climb. In other words, (4.70d) is not stating that Fiona was a girl for exactly (or even approximately) the time that it took Emily to climb her mountain. Instead, it conveys that there is a relation of temporal inclusion between the two eventualities — the event is temporally included in the state.

But why should it be the case that only one TIME-OF Role is present in (4.70a,4.70d)? One way we could get this to happen would be to say that only one situation, as opposed to two, is described by (4.70a,4.70d). Thus we would be suggesting that when an event description is followed by a state description, *the state sentence does not cause a new situation to be described, but adds further information about the first situation.*

The fact that no new situation is introduced by the stative sentence means that there is no second TIME-OF Role introduced into the discourse context. The presence of only one TIME-OF Role licenses 'at the time' and rules out 'at the same time' for this kind of sequence, which is exactly what we require.

It is important to note that we are not proposing that stative sentences never introduce "new" situations. Our proposal is, rather, that a state description following an event description causes no new situation to be introduced. The important notion is that of **backgrounding**. When a stative sentence follows an event sentence, the discourse relation is one of backgrounding, and we are proposing that when the second eventuality backgrounds the first, no new situation is introduced but further information is given about the old situation. We will see below that stative sentences do not have to background (for example, if they follow another stative, or if modified by a 'for'-adverbial). Thus the "no new situation" proposal is one that concerns discourse backgrounding, not primarily the distinction between events and states in themselves, although the two notions can be shown to interact (see Glasbey 1994a) for discussion).

Definition:

> An eventuality e_2 **backgrounds** a previously described eventuality e_1 iff e_2 introduces no new situation into the discourse context but rather adds further information to the situation corresponding to e_1.

Our proposal thus differs from superficially similar ideas put forward by Galton (1984), Löbner (1985), Herweg (1991) and Sandström (1993). These authors propose that stative sentences[22] refer to propositions rather than referring to entities that are occurrences of events in the way that event descriptions do. Seligman and ter Meulen (1992) propose something similar, whereby a stative adds further information to a state-of-affairs previously described in the discourse rather than introducing a new state-of-affairs. Our proposal is different in that, as we have already pointed out, it relates to backgrounding rather than to stativity in itself. We argue in (Glasbey 1994a) that the notions of stativity and backgrounding, although related, need to be kept distinct.

Let us consider how to represent the "no new situation" proposal. Suppose we have already "processed" (4.70a) to obtain the representation {21}. Now, what happens when we come to (4.70d)? No new situation is introduced, so we simply want to say that the new infon is also supported by S_1. Thus we add the infon:

girl(X_2, T_1)	R_2 named(X_2,'Fiona')

[22]Which are taken to include progressives and perfects.

to S_1, giving:

<table>
<tr><td colspan="2">$r_1 \rightarrow S_1$, $r_2 \rightarrow X_1$, $r_3 \rightarrow Y_1$, $r_4 \rightarrow R_1$, $r_{4b} \rightarrow T_1$, $r_5 \rightarrow X_2$, $r_6 \rightarrow R_2$</td></tr>
<tr><td>S_1

climb(X_1, Y_1, T_1)
girl(X_2, T_1)</td><td>R_1
named(X_1,'Emily')
named(Y_1,'Ben Nevis')

R_2
named(X_2,'Fiona')

S_1, climb(X_1, Y_1, T_1)
KEY

S_1, T_1
TIME-OF</td></tr>
</table>

Note that the new infon we have introduced is also a key infon of S_1. Thus we should add this information to the representation, giving as our complete representation for (4.70a,4.70d):

$r_1 \rightarrow S_1,\ r_2 \rightarrow X_1,\ r_3 \rightarrow Y_1,\ r_4 \rightarrow R_1,\ r_{4b} \rightarrow T_1,\ r_5 \rightarrow X_2,\ r_6 \rightarrow R_2$

S_1

$\mathrm{climb}(X_1, Y_1, T_1)$
$\mathrm{girl}(X_2, T_1)$

R_1

named(X_1,'Emily')
named(Y_1,'Ben Nevis')

R_2

named(X_2,'Fiona')

$S_1, \mathrm{climb}(X_1, Y_1, T_1)$

KEY

$S_1, \mathrm{girl}(X_2, T_1)$

KEY

S_1, T_1

TIME-OF

{24}

In {24} we have exactly one TIME-OF Role, which accounts for the acceptability of 'at the time' but not 'at the same time' in this sequence.

This representation captures the intuition we have about (4.70a,4.70d) that the second sentence does not talk about the "whole situation" of Fiona's being a girl (i.e. the situation which has as its duration the total length of Fiona's girlhood — if indeed this notion has any meaning) but rather talks about a situation involving the portion of Fiona's girlhood that coincides with Emily's climb.

We have therefore proposed an analysis of discourse backgrounding whereby the backgrounded eventuality does not introduce a new situation but adds more information to the situation in the current discourse context. This explains why only one TIME-OF Role is present, which in turn explains the distribution of 'at the time' and 'at the same time'.

Remember that we pointed out that, unlike PART-OF 'then', 'at the time' is not acceptable following an elaboration. We characterised PART-OF 'then' as conveying that the second eventuality is part of the first, either by virtue of backgrounding or elaboration. 'At the time', on the other hand, specifically conveys backgrounding.

We can explain this as follows. Although an elaboration sequence conveys that the second eventuality is part of the first, it does *not* convey that both sentences describe the same situation. This seems intuitively correct. For example, the sequence:

(4.71) a. Emily climbed Ben Nevis
b. She saw an eagle

(on an elaborative reading) does not convey that the TIME-OF the eagle-seeing eventuality was the same as the TIME-OF the complete climb, but rather that the eagle-seeing was temporally included within the complete climb. Thus we need two separate TIME-OF Roles here, unlike the backgrounding case where only one was required. But this requires that we have two situations rather than just the one — where the second situation is part of the first. The two TIME-OF Roles mean that 'at the time' is ruled out and predict that 'at the same time' is required.

But of course we also noted earlier that 'at the same time' is not acceptable here. The intuitive explanation is simply that the times of the two events are not the same. But remember that we also have to explain why:

(4.72) a. Emily climbed Ben Nevis
b. *She achieved her ambition at the same time

is not acceptable, even though the two times are arguably the same here. (Perhaps it is better to consider the example:

(4.73) a. Emily reached the top of Ben Nevis
b. *She achieved her ambition at the same time

if it is considered that the achieving of Emily's ambition coincides with her reaching the top rather than with the climb as a whole. This sequence is equally unacceptable, of course.)

Thus it appears that we are required to stipulate that the two events must be "distinct" in order to use 'at the same time'. Perhaps we should say that they are "conceptually distinct"? Rather than pursue this matter further here, we will simply include in our representations for 'at the same time' the information that the two eventualities are of type CONCEPTUALLY-DISTINCT (CD) and leave it to further investigations to decide exactly what this means.

Let us now consider the examples involving the progressive.

Consider (4.70a,4.70f) and (4.70a,4.70g):

(4.70) a. Emily climbed Ben Nevis
f. Fiona was climbing Snowdon at the time
g. Fiona was climbing Snowdon at the same time

As we remarked earlier, it is interesting to note that both these sequences are acceptable — that either 'at the time' or 'at the same time' is appropriate where a progressive follows an accomplishment. We can explain this if we assume that the progressive may have either a backgrounding or a non-backgrounding function in a sequence like the one above. In (4.70a,4.70f), the progressive causes Fiona's climb to be backgrounded with respect to Emily's climb, and according to our analysis of backgrounding above we obtain the representation:

<table>
<tr><td colspan="2">$r_1 \rightarrow S_1,\ r_2 \rightarrow X_1,\ r_3 \rightarrow Y_1,\ r_4 \rightarrow R_1,\ r_5 \rightarrow T_1,\ r_6 \rightarrow X_2,\ r_7 \rightarrow Y_2,\ r_8 \rightarrow R_2$</td></tr>
<tr><td>S_1

climb(X_1, Y_1, T_1)
climbing(X_2, Y_2, T_1)</td><td>R_1
named(X_1,'Emily')
named(Y_1,'Ben Nevis')

R_2
named(X_2,'Fiona')
named(Y_2,'Snowdon')

S_1, climb(X_1, Y_1, T_1)
KEY

S_1, climbing(X_2, Y_2, T_1)
KEY

S_1, T_1
TIME-OF</td></tr>
</table>

{25}

Note that we do not attempt to represent the semantics of 'climbing' here. Our use of the relation 'climbing' is intended to convey that Fiona's climb was not necessarily completed. In (Glasbey 1994a) we give an analysis of the progressive which captures how the truth conditions of 'Fiona was climbing Snowdon' relate to those of 'Fiona climbed Snowdon'.

Now compare (4.70a,4.70g). Here, we have suggested that the progressive does **not** convey a backgrounding function. Because this is the case, the representation for (4.70g) involves two situations, S_1 and S_2.

$r_1 \rightarrow S'$, $r_2 \rightarrow X'$, $r_3 \rightarrow Y'$, $r_4 \rightarrow R'$, $r_5 \rightarrow T'$,
$r_6 \rightarrow S''$, $r_7 \rightarrow X''$, $r_8 \rightarrow Y''$, $r_9 \rightarrow R''$

S'

climb(X', Y', T')

R'

named(X','Emily')
named(Y','Ben Nevis')

S', climb(X', Y', T')

KEY

S',T'

TIME-OF

S''

climbing(X'', Y'', T')

R''

named(X'','Fiona')
named(Y'','Snowdon')

S'', climbing(X'', Y'', T')

KEY

S'',T'

TIME-OF

S',S''

CD

{26}

Thus two instances of the TIME-OF Role are present, and 'at the same time' is appropriate.

Note that our analysis of the progressive as backgrounding in (4.70a,4.70f) but not in (4.70a,4.70g) is supported by the intuition that (4.70a,4.70f) conveys the impression that Fiona's climb took a much longer time than Emily's, whereas in (4.70a,4.70g) the two climbs could well have taken approximately the same length of time.

We have seen that a progressive following an event description may convey either a backgrounding or a non-backgrounding function, shown by the fact that both 'at the time' and 'at the same time' are possible in this case. This means that it is important that we separate the notions of 'backgrounding' and 'stativity', which have often been treated as one and the same thing in the literature (although the term 'backgrounding' has not always been explicitly used). We explore this distinction further in (Glasbey 1994a).

We saw too that a state following an event description **must** convey that the state is backgrounded with respect to the event. We will now examine what happens in the case of sequential descriptions of states.[23]

Let us therefore now examine some examples where both eventualities are states:

(4.74) a. Mary was ill
b. She was in London at the time

We can explain the acceptability of 'at the time' in this sequence if we say that the state described by (4.74b) backgrounds the state described by (4.74a). Thus we are assuming that states can background other states, which seems reasonable if the backgrounding state is of considerable longer duration than the other one.

Now consider:

(4.75) a. Mary was in London
b. John was there at the same time

[23]It might be asked what exactly is the function of the progressive in (4.70a,4.70g), given that it does not express backgrounding here. One thing that it conveys, of course, is that the event was not (necessarily) completed. See (Glasbey 1994a) for a more detailed analysis of the progressive.

Thus 'at the same time' is acceptable here and it seems that what is conveyed is that John and Mary were in each London, for at least approximately the same length of time. This ties in with our analysis of 'at the same time', if we relax slightly the requirement that the two eventualities coincide exactly (in fact we need to allow this relaxation for the non-stative examples too, as it is unlikely that, for example, two climbs even of the same mountain let alone different ones will take exactly the same length of time). In (4.75a,4.75b), the second state does **not** background the first, and this is why 'at the same time' is appropriate. Thus we see that a stative sentence following another stative sentence need not convey backgrounding, in contrast to a stative following a non-stative which must convey backgrounding.

There is a complication for the stative examples, however. Some informants find that the sequence:

(4.76) a. Mary was in London

b. John was in Paris at the same time

sounds a little odd. They report that it is almost as though we are forced into inferring that Mary was in Paris too, and that John's stay in Paris coincided (at least approximately) with hers. This is unexpected, because we were not required to make any comparable inferences in the case of the non-stative examples. This example is reminiscent of the non-temporal examples where we had to infer another instance of the same generalised Role in order for 'the same X' to be acceptable. It is as though two instances of the Role TIME-OF is not enough to license 'at the same time' in this case. But why should the statives work differently in this way? This is an intriguing question, which is further complicated by the fact that not all informants find this sequence odd or find it necessary to infer that Mary was in Paris in order to interpret it. We leave this aside as a topic for further investigation.

We have seen, then, that a state immediately following an event in discourse conveys backgrounding, which means that 'at the time' but not 'at the same time' is acceptable in these cases. We discovered, too, that an event described in the progressive can either act as backgrounding or non-backgrounding with respect to an event described immediately before it in the discourse. We can also make the observation that an event does not background a previous event in the discourse unless the backgrounding event is described in the progressive.

Our observations highlight the need to keep distinct the notions of backgrounding and stativity. These two concepts have sometimes been merged in the literature, where 'state' has been seen as a "classification of narrative function". This is what is meant, of course, by the claim that the progressive is a stativiser. But we have seen that this is an oversimplification, and that the progressive *may* convey backgrounding but does not always do so.

This leaves us, of course, without a definition of the distinction between states and events. We pursue this further in (Glasbey 1994a), where we suggest how the distinction may be formalised in a way that is separate from the backgrounding/non-backgrounding distinction and hence allows us to express how these distinct notions interact.

Our proposal that discourse backgrounding involves further specification of the situation described by the previous sentence has allowed us to explain why 'at the time' is appropriate in backgrounding cases and 'at the same time' in non-backgrounding cases. This ties in very well with our account of 'the X' and 'the same X' in discourse, where the former requires exactly one instance of a generalised Role and the latter requires more than one instance. The notion of generalised Role has thus enabled us to formalise the notion of discourse backgrounding which has been widely used in accounts of discourse structure,[24] but has not as far as we know been formally defined. We have also highlighted the necessity to keep distinct the notions of stativity and discourse backgrounding.

There may be a problem, however, with our proposal that backgrounding eventualities do not introduce new situations. Consider, for example, the sequence:

(4.77) a. Daniel climbed Ben Nevis
b. Emily was climbing Snowdon at the time

Now suppose we follow (4.77a,4.77b) with:

[24]Such as (Mann and Thompson 1987)

(4.77) c. Mary saw it from a helicopter

What can 'it' in (4.77c) refer to? For some speakers, 'it' can be used to refer either to the situation that comprises both climbs (which of course is ruled out in this case by world knowledge, although we can construct other examples where this is not so), or to Emily's climb alone. Yet, according to our analysis, Emily's climb is backgrounding and there is no situation that corresponds to her climb alone, which means that we should not be able to refer to Emily's climb alone as 'it'. Other speakers, however, report that 'it' cannot be used in this way to refer to Emily's climb alone, but must refer to both climbs — which supports our analysis.

Thus here we have what might be seen as some counter-evidence to our proposal. However, it is far from conclusive, and is particularly hard to interpret owing to the variations in speaker intuitions. In contrast, the intuitions about 'at the time' were shared by all our informants, suggesting that the evidence here is far more reliable than the evidence from 'it' anaphora.

Given that our proposal allows us to explain the distribution of 'at the time' and 'at the same time' in a way that accords so well with the non-temporal cases, we will retain it, while noting the problem with 'it' anaphora. We are left with the problem of finding a way to explain the latter, which we suspect will not be easy. One way to do this may be to allow the hearer to "construct" a separate situation corresponding to Emily's climb alone upon hearing the sequence (4.77a,4.77b,4.77c). This would involve the hearer "unbackgrounding" Emily's climb and giving it the status of a separate situation, which can then be referred to by the pronoun. This operation sounds rather complex and unwieldy, which might explain why it is difficult for some speakers.

4.4.3 Summary

We have shown in this section that our analysis of 'the X' and 'the same X', where X is a relational noun, can be successfully applied to explain the distribution of 'at the time' and 'at the same time'. This has given us a way to formalise the discourse relation **backgrounding**, which has been shown in the literature to be a useful notion but which has not previously, as far as we are aware, been formally defined.

4.5 Conclusion

We began this chapter by asking why the distribution of 'at the time' and 'at the same time' should be the way it is. In order to shed some light on these temporal phrases, we turned to what appeared to be related phenomena in the non-temporal domain, involving the distribution of 'the X' and 'the same X' in discourse sequences.

We developed an analysis of 'the X' and 'the same X' which explains the distribution of these phrases in discourse sequences. Following this, we went on to show that the account can be generalised to cover non-relational uses of 'the same X' and single-sentence examples involving 'the same X'.

Our analysis used the notion of **generalised Role**. The basic idea was that more than one instance of the same generalised Role requires 'the same X', whereas a single instance of the generalised Role requires 'the X'. We saw too that the notion of generalised Role is relevant to object-NP coordination examples in general, not just to examples involving 'the same'.

We investigated to what extent our notion of generalised Role is related to the traditional notion of thematic role. We showed that the generalised Roles we propose may be characterisable in terms of sets of entailments in a similar way to the Proto-Agent and Proto-Patient Roles proposed by Dowty (1991). We would however need to distinguish between a larger set of Proto-Roles than the two proposed by Dowty.

We then applied our analysis to 'at the time' and 'at the same time' and showed how it explains the distribution of these phrases and how this leads to a way to give a formal definition of the discourse relation **backgrounding**.

Our analysis is in some respects broader in scope than those of Carlson (1987) and Moltmann (1992), in that these authors restrict themselves to sentence-internal and non-relational uses of 'the same X' and do not consider 'the X'. Our account deals in addition with sentence-external (discourse) and relational uses of 'the same X' and 'the X'. On the other hand, we have not considered in detail the quantificational and other syntactic contexts that Carlson and Moltmann both address. Further work is needed to explore how our account might be extended to include such cases.

It should also be pointed out that we have made no mention of 'different'. We speculate that our analysis of 'the same' could be applied fairly readily to corresponding uses of 'different' — perhaps by saying that 'different' precludes rather than enforces the merging of roles, and forces the roles to be assigned to distinct parameters. This is, however, an untested speculation.

In general, our account demonstrates the importance of inference in the analysis of natural language, and highlights the need to distinguish in our formal representations between explicitly presented (described) information on the one hand and inferred information on the other. One way that this distinction might be made is in terms of updating mental states, as in (Cooper and Ginzburg 1993).

Chapter 5

Event Structure and Aspect

Note: Material from this chapter and from Chapter 3 has appeared in (Glasbey 1993c).

5.1 Introduction

In Chapter 2 we introduced our observations about 'then' and developed a theoretical analysis. We identified various constraints which must be respected whatever representational framework is used, and developed a DRT fragment which expresses these constraints by making a formal distinction between **events** and **times**. We explained that this account worked well for the fragment under consideration and there did not appear to be any immediate problems in scaling it up to larger fragments. However, we pointed out that there might be instances where it would become necessary to introduce temporal discourse referents even in cases where these were not introduced by an explicit temporal referent (ETR). (In fact we considered some cases like this in Chapter 4, where we expressed the meaning of 'at the time' and 'at the same time' in terms of "time roles".) For this reason, in Chapter 3 we recast the fragment in a situation theory/DRT framework and showed how situation theory's ability to encode information about the utterance enabled us to capture the distinction we need while not restricting the introduction of temporal discourse referents to cases where an ETR is present. This allowed us to write a grammar which should be more readily extendable to larger fragments.

In Chapter 4 we began by turning our attention to 'at the time' and 'at the same time', which we had considered briefly in Chapter 2. In order to make sense of the observations and to give a deeper explanation, we considered a range of related non-temporal examples involving expressions like 'the colour' and 'the same colour'. We developed a theoretical analysis of 'the X' and 'the same X' where X is a relational noun such as 'colour', and showed how this can be formalised in situation theoretic DRT (STDRT). Applying our account to the temporal examples allowed us to explain the observations involving 'at the time' and 'at the same time'. It also led us to propose a way to formalise the notion of discourse backgrounding.

Thus, in Chapters 2–4, our primary focus was at a "discourse" level of analysis, involving the relations between eventualities conveyed by successive sentences of a discourse. Of course, in developing grammar rules we were forced to consider issues such as the progressive which have traditionally be dealt with on an intra-sentential level. However, such topics as the analysis of the progressive and aspectual class distinctions were not our main concern, and we gave what we consider to be a rather perfunctory treatment of these. In the current chapter we will investigate how the theory we have developed so far can be applied to aspectual class and aspectual composition, which are traditionally dealt with at a sentential level of analysis.

In this chapter we discuss the various approaches to aspectual class and aspectual composition that have appeared in the literature in recent years — in particular, those of (Moens 1987), (Verkuyl 1989) and (Krifka 1992). This will enable us to develop an STDRT account which incorporates insights from these sources. We will show how our account could be used as the basis for extension and improvement of the fragment presented in Chapter 3.

We hope to show that situation theory provides us with a useful framework for expressing the structure of events. This is not to claim that situation theory is the only theory in which such an account of events can be expressed. We will demonstrate, however, that it provides us with some useful tools and concepts for the task at hand, as well as providing compatability with the DSTG framework in which the grammar rules are formulated.

5.2 Aspect and Aspectual Class

Terms such as 'aspect', 'aspectual class', 'aspectual type' and 'aktionsart' are widely used in the literature, often in subtly different ways. It is important that we establish at this point which terms we are going to use and how we will use them.

'Aspect' is often used in a fairly general way to refer to something like "the linguistic apparatus used to establish the internal temporal structure of a state of affairs". (See Moens 1987, p.38ff for a detailed discussion of this and related terminology in the tense and aspect literature.) Such aspectual differences can be grammaticalized, for example by means of aspectual affixes on verbs (an example is the progressive 'be' + 'ing' construction in English). This gives rise to the perfective/imperfective distinction widely used in the literature, and is also used to cover notions such as duration, instantaneity, frequency and so on (again, see Moens 1987, p.39 for discussion). Aspectual information is also present (in some sense, to be discussed shortly) in lexical material. Verbs have sometimes been classified in order to reflect the aspectual distinctions they express, such classes being referred to as **aktionsarten**.

One classification which has been adopted by many researchers is that of (Vendler 1967), who identifies the classes **states**, **activities**, **accomplishments** and **achievements**. However, although many have taken Vendler's taxonomy to be a classification of verbs, it is clear from his paper that Vendler was concerned with classifying not just verbs but verb phrases such as 'run a mile', according to what he calls the "time schemata" of the events they describe. Later authors such as Dowty (1979) have shown clearly that the Vendler classification is better seen as a classification of the meanings of whole sentences, given that object noun phrases, subject noun phrases, locative complements and temporal adverbials may all affect aspectual class. However, we are still left with the fact that the verb "in itself" contributes *something* to the overall aspectual class of the state of affairs described by the sentence. The problem is to decide exactly what it is that the verb contributes, and how best this may be characterised.

Moens proposes that we regard the Vendlerian taxonomy as "dynamic" in nature, as opposed to seeing it as a fixed classification. The idea is that a verb like 'run' is assigned a "basic aspectual class"[1] but is capable of changing category provided that the context (linguistic and non-linguistic) is able to support the necessary assumptions relating to the transition. We will discuss Moens' approach to aspectual modification in more detail shortly.

An alternative approach is that of Verkuyl in (Verkuyl 1972) and (Verkuyl 1989), who argues that it is wrong to adopt an aspectual classification of verbs. He maintains that aspectual class does not exist at a syntactic level lower than that of VP, and that a better approach is to assign features to verbs which determine their contribution to the aspectual class of the VP. The properties of any object NPs (such as their mass/count nature) also contribute to the determination of aspect at VP level. 'Sentential' aspect is then formed by a combination of VP aspect and the properties of the subject NP.

Because Verkuyl rejects the notion of "basic aspectual class/type" for verbs, his and Moens' accounts look radically different at first glance. However their accounts are not as dissimilar as they may at first appear, since they share the idea that the aspectual class of an event as described by a sentence is built up or derived from the aspectual properties of the constituents. Their accounts differ in the detail of how these aspectual interactions are represented. We will discuss Verkuyl's approach in more detail shortly.

Moens (1987) makes it clear that he regards aspectual class distinctions as "subjective" in nature, insofar as they reflect the speaker's way of describing the world, rather than being a classification of real world events. He argues that the same state of affairs can be described in different ways, corresponding to different aspectual classes. For example, the sentences:

(5.1) I wrote two letters last night

and:

[1] To be more precise, Moens makes it clear that basic aspectual class is a classification not of a verb but of a sentence containing the verb, in a "null context" where no linguistic or other factors are present to induce a change in aspectual class. See later for more on this.

(5.2) I wrote letters last night

may both be used to describe exactly the same state of affairs, while (5.1) is classified as a culminated process (equivalent to a Vendler accomplishment) and (5.2) as a process (Vendler activity). This is a very appealing argument, but it begs the question of what exactly is meant by 'the same state of affairs' — an intuitive notion which it is not easy to see how to define. We will see shortly how situation theory helps us to clarify the idea.

Verkuyl (1989), on the other hand, appears to view aspectual class distinctions as objective properties of events. Because of this, he rejects the distinction between accomplishments and achievements, arguing that 'draw a circle', traditionally an accomplishment, becomes effectively an instantaneous action (an achievement) when done by means of a computer. Thus the real-world distinction between accomplishments and achievements is blurred and it becomes unnecessary, Verkuyl argues, to make the distinction at all. Others, such as Smith (1991), see aspectual class distinctions as pertaining to the way that events are classified by speakers. Smith argues (p.30) that while no event is "truly instantaneous" in an objective sense, the accomplishment/achievement distinction is still important in that it involves the way that the speaker chooses to classify and describe the event in question. The fact that it is a conceptual notion rather than an objective, speaker-independent one does not render it a unnecessary distinction to make, and Smith argues that it is an important linguistic category.

In our situation-theoretic account, we will use the term 'aspectual class' as a classification of situations of a certain type — those we call 'eventualities'.[2] Recall that in Chapter 3 we defined an eventuality to be a situation which has one or more key infons.

In regarding Vendler class as a way of classifying situations we follow Cooper (1985), who similarly used Vendlerian distinctions to classify situations, although we adopt a more current version of situation theory and we use Moens' aspectual taxonomy. Situations are not linguistic in nature; they are parts of the world that

[2]Thus we are not claiming that all situations are eventualities, but rather that all eventualities are situations. We use the term 'eventuality' as in Chapter 3 to cover both states and events (Bach 1986).

language users may describe using linguistic expressions. Thus in our terminology, 'process', for example, does not classify a certain kind of sentence but a certain piece of non-linguistic reality.[3] However, we avoid Verkuyl's claim that such a classification must necessarily be "objective" in the sense that there is something about the world that determines, independent of anyone's viewpoint, whether something is or is not a process. In situation theory, situations are parts of the world as individuated by agents. Thus a language-using agent discriminates a part of the world as a situation of type EVENTUALITY, and classifies it as a process, a culminated process or whatever.

Thus, our seeing aspectual class as applying to situations allows us to account for the fact that the same bit of reality may be classified in different ways by different agents (or even by the same agent). That is, what we might intuitively think of as the "same event" where someone called John eats some apples, may be described by one agent as 'John ate apples' (a process) and by another as 'John ate the apples' (a culminated process). In other words, the same event may be presented in more than one way in terms of informational structure. Situation theory provides us with an informational perspective on events which gives us a clear way of characterizing what aspectual class is "about". It allows us a more fine-grained classification than that of Verkuyl, while at the same time showing how properties of linguistic objects link up to properties of non-linguistic objects, which is surely an appropriate goal of linguistic semantics.

However, if we use aspectual class to classify situations, we are left with the problem of deciding how it is that a particular sentence describes a situation of a particular aspectual class. We will need to assign some kind of features or properties to the constituents of a sentence (or to their referents) and then show how these features combine together in such a way that the sentence describes a situation of a particular aspectual type. It is clear that some basic property or properties of the verb, together with properties of subject and object NPs and any temporal adverbials that may be present, are all relevant here.

We saw above that the approach taken by Moens is to employ the notion of a "basic" aspectual class associated with a verb. This basic aspectual class may be

[3]We will however sometimes speak of a 'process sentence', for example, to refer to a sentence that describes an eventuality that is a process.

modified when the verb combines with other constituents of the sentence. This process of aspectual modification Moens calls **coercion**. Thus, for example, to the verb 'climb' he ascribes the basic aspectual class **process**. When 'climb' combines with certain types of direct object NP (e.g., a count noun plus a determiner), the process is coerced to a **culminated process**.[4] Moens develops an **aspectual network** of permitted coercions, which clearly shows which transitions between aspectual classes are permitted, and under what circumstances.[5] He explains the various possible coercion using an **event nucleus**, which we will discuss in detail shortly. This provides a very clear summary of aspectual modification and the conditions under which it occurs. It is an approach which lends itself very well to implementation, and was used by Glasbey (1990) as the basis for a Prolog system developed to parse a fragment of English sentences with tense and aspect. There, the author used Moens' coercion network provided the basis for a compositional analysis of sentences involving progressives, perfects, temporal adverbials and verbs of various aspectual classes.

There appears, however, to be something rather arbitrary about whether we choose to call 'climb' a process or a culminated process. 'Climb a mountain' is a culminated process; 'climb mountains' is a process.[6] Of course we could decide to take the intransitive use of the verb and use that to determine aspectual class. 'John climbed' can be shown to be a process — so maybe we should take this to be the basic aspectual class. But it is not clear that all transitive verbs have intransitive uses. Moens (1987) (p.94) finds a way around this problem by specifying the exact conditions under which "basic aspectual class" is assigned. He makes it clear that the aspectual categories actually apply to "propositions conveyed by sentences in context". In order to determine the aspectual category of a verb, he specifies that "the subject of the basic proposition should be syntactically singular [and] ... the object should be a singular count noun and should only be present in the case of a necessarily transitive verb ...". Thus, in Moens' words "... the statement that 'run' is a process verb is really a shorthand for the statement that the basic proposition involving this verb, for example 'John ran', is typically a process expression".

---

[4] A Vendler **accomplishment**.

[5] These include general world knowledge, context, and linguistic features such as the presence of the progressive.

[6] See (Dowty 1979) for tests to distinguish between these.

Thus the assigning of basic aspectual class to a verb may be seen as a somewhat arbitrary decision. There is nothing necessarily wrong with this as long as the conditions for the assignment are carefully defined, which Moens does. It may be argued, however, that the arbitrariness arises because there is really no such property as aspectual class at the verbal level. Verkuyl believes that this is so, and that what is present at the verbal level are features, which combine with features of object NPs, for example, to give aspectual class at the VP level. Thus what we are calling aspectual class (and Verkuyl calls aspect) only comes into being at VP level and above. Rather than having aspectual class, a verb is specified with regard to what Verkuyl calls a 'meaning element', which determines its contribution to the aspect of the VP and ultimately that of the sentence. Thus Verkuyl rejects what he sees as the Vendler classification of verbs, arguing that the classification is an ontological one, and he also rejects the notion of basic aspectual class. Verkuyl's meaning elements, which are responsible for this interaction, are seen in his earlier treatment (1972) as syntactic features only. They correspond to some intuitive notions but are not formally defined. However in his later (1989) paper, model theoretic definitions are given, which somewhat increase the explanatory power of his account. Verkuyl's treatment of aspectual composition will be compared later with that of Krifka (1992), who adopts an approach that is similar in some respects.

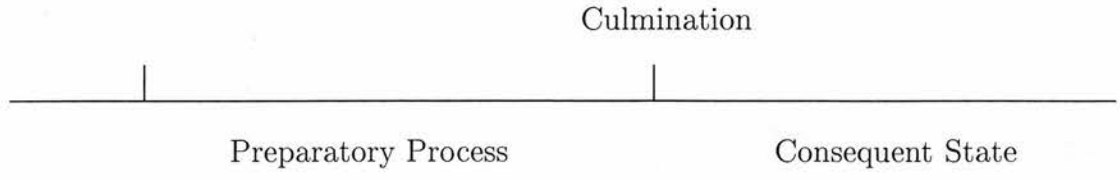
We will develop an account of aspectual composition which does not use the notion of basic aspectual class of a verb. Instead we will assign features to relations, agents, patients, times, places and so on (i.e., to real world objects as discriminated by agents). We will show how these semantic features combine together to give the resultant aspectual class of the described eventuality. To do this we will use ideas from both Verkuyl and Krifka.

The first thing we need to do is to express formally the difference between the aspectual classes. We will refer to these, using Moens' terminology, as **states**, **processes**, **culminated processes** and **culminations**,[7] which correspond to Vendler's original classes of **states**, **activities**, **accomplishments** and **achievements** respectively.

Moens (1987) proposes a nucleus model for events, where an event consists of

[7]We will not consider **points** here.

a preparatory process, a culmination, and (in some cases) a consequent state. Linguistic descriptions of events pick out and refer to one or more phases of the nucleus.



Thus Moens would say that 'Daniel climbed Ben Nevis' refers to a culminated process consisting of a preparatory process (the climbing) and a culmination (the arrival at the summit). The perfect 'Daniel has climbed Ben Nevis' refers to the consequent-state phase of the event. The progressive 'Daniel was climbing Ben Nevis' refers to the preparatory process (or part of it), but does *not* refer to the culmination (which helps to explain why use of the progressive makes no claim about the event having been completed). Thus Moens regards the function of the progressive as being to "chop off" the culmination from a culminated process, leaving a process. In his account, the progressive then coerces the process to a particular kind of state called a progressive state, according to one of the transitions in the aspectual network.

'Daniel reached the top' refers to a culmination alone and not to a preparatory process. Of course there is an associated preparatory process, which we might refer to with the sentence 'Daniel climbed'. We can specify the temporal extent of this preparatory process by combining the culmination sentence with a (completive) 'in'-adverbial, e.g.:

(5.3) Daniel reached the top in four hours

Note however that the progressive sentence:

(5.4) Daniel was reaching the top

cannot be used to refer to any arbitrary part of the preparatory process we associate with the culmination. It appears that (5.4) can only be used to refer to some "final part" of the preparatory process. Thus we see that it is important to distinguish between those parts of an event which are directly referred to by a sentence, and those which are not directly described but which the hearer is somehow able to infer. We will consider such examples in more detail shortly. First, we will consider how to formalize Moens' event structure in a situation theoretic framework.

5.3 Event Structure in Situation Theory

5.3.1 Situations, infons and aspectual class

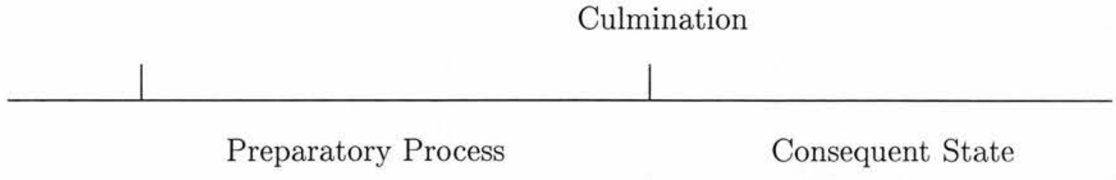
We took the decision in Chapter 3 to regard events and states as situations of type EVENTUALITY. This seems intuitively reasonable. In common parlance, we use the term 'event' to refer to happenings both large and small. For example, we speak of an event of Daniel climbing Ben Nevis, or of Mary writing her thesis, or of John typing a single letter 'k' at the keyboard. We often conceive of events as consisting of component sub-events. Many events are "temporally connected" in the sense that there are no temporal gaps in them — but this is not always the case. Clearly, it is very difficult if not impossible to define in some ontological sense what is or is not meant by an event, and we will not attempt to do so here.

Situations in situation theory may also be of any size. They may be classified as supporting a large number of infons or just one. They may be temporally and/or spatially connected or otherwise. Situation theorists view situations as parts of the world as perceived or individuated by agents. This appears to fit very well with the way we use the terms 'event' and 'state'. We do not want to say that all situations are eventualities, but it seems appropriate to think of an eventuality as a particular kind of situation.

Let us consider how to express a Moens "event nucleus" in these terms. We first define a type NUCLEUS to classify situations which have Moens' nucleus structure.

Definition:

A situation is of type NUCLEUS if it has the structure:



We observe that single clauses (corresponding to single infons) do not appear to describe situations of type NUCLEUS, but rather they describe parts of such situations. For example, an utterance of 'Daniel climbed Ben Nevis' describes the preparatory process plus the culmination, while 'Daniel was climbing Ben Nevis' describes the preparatory process (or part of it), and 'Daniel has climbed Ben Nevis' refers to the consequent-state of the event.

We propose to regard each phase of the nucleus as a situation of type EVENTUALITY. We then introduce binary types such as PREP, CULM and CONS, which hold between these eventualities. For example:

$$\begin{array}{|l|}\hline \mathrm{S}_1, \mathrm{S}_2 \\ \hline \text{PREP} \\ \hline \end{array}$$

is the proposition that S_1 is the preparatory process of S_2 and:

$$\begin{array}{|l|}\hline \mathrm{S}_1, \mathrm{S}_2 \\ \hline \text{CULM} \\ \hline \end{array}$$

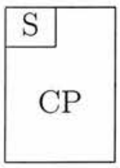
is the proposition that S_1 is the culmination of S_2.

We use binary types in this way rather than defining unary types such as:

$$\begin{array}{|l|}\hline \mathrm{S}_1 \\ \hline \text{PREP} \\ \hline \end{array}$$

in order to capture the fact that what is important here is not some property of a situation in itself, but rather the way that the situation is related to one or more other situations. It may be possible, for example, for a given situation S_1 to be the preparatory phase of one event and the consequent state of another. In suggesting this we follow Mellor (1993), who uses a similar idea to analyse inceptives.

Now we need to decide how to represent aspectual information about situations. Here, it appears that we may need unary types, for example:



to express the proposition that S is a culminated process (CP). We will explore this further and give a definition for CP shortly. First, we will recap on what we said in Chapter 3 about situations, infons and the notion of KEY.

We noted in Chapter 3, Section 3.5.2, that in considering eventualities as situations we need to be clear which situation we are talking about. What we require is a notion of eventuality which corresponds to the "smallest" situation that supports the infon in question. We used the notion of 'key infon' presented in (Cooper 1985), and we introduced a binary type KEY that holds between a situation and an infon, where the time of that infon includes the times of all other infons supported by the situation.

We saw that:

$S, \sigma(T) : \text{KEY} \rightarrow S, T : \text{TIME-OF}$

where we call T the time Role or TIME-OF Role of S.

In order to deal with aspectual class, we will assign an aspectual class (such as PROCESS or CP) to an infon σ, and we will allow that aspectual class to be "transmitted" to the situation S of which σ is the key infon. We need to be careful here, however, as it is possible for a situation to have more than one key infon. If a situation S has, say, two key infons, of differing aspectual classes, which aspectual class does S inherit? In order to avoid this problem, we will define a special kind of eventuality which has at most one key infon. We will introduce a new type, EVY, for eventualities of this kind, and define it as follows:

Definition

$$\forall S\ [S : \text{EVY iff } [\forall \sigma_1, \sigma_2[S, \sigma_1 : \text{KEY} \ \& \ S, \sigma_2 : \text{KEY}] \ \rightarrow \ \sigma_1 = \sigma_2]]$$

We will also introduce a new binary type of situations and infons, KEY_0, where:

$\forall S, \sigma\ [S, \sigma : \text{KEY}_0 \text{ iff } [S, \sigma : \text{KEY} \ \& \ S : \text{EVY}]]$

Now we need to consider how to define the types STATE, PROCESS, CP, CULM (culmination) and POINT, corresponding to Moens' aspectual types. We said above that we will view these as unary types both infons and eventualities.

We will leave aside here the distinction between states and processes (see Glasbey 1994a for discussion and a proposal regarding this). To begin with, we will concentrate on the distinction between processes and CPs.

In the literature, the distinction has been expressed in terms of the **subinterval property** or **homogeneity** (Bennett and Partee 1972, Dowty 1979). The basic idea is that if an event is a process (or state), all sub-events are of the same type as the main event. For example, an event of John running, described as 'John ran', may be divided up into an indefinite number of sub-events, each of which is also an event of John running, describable as 'John ran'. This is the property of **homogeneity** that has been used to characterise process events.[8] An alternative way to express the same idea is to say that if the event 'John ran' had temporal duration t, then every subinterval of t can also be associated with an event of type 'John ran'. This gives rise to the term **subinterval property**. Cooper (1985) uses a related but different notion to distinguish between states and processes on the one hand and CPs and culminations on the other. He characterises states and processes as having the property of **temporal ungroundedness**, which says that for every event of (say) John running, there is another event of John running temporally included in it. We will discuss this definition in more detail below.

By contrast, CPs, culminations and points do *not* in general have sub-events of the same type as the main event. If a CP, culmination or point occurs at

[8] See below for a discussion of problems associated with this definition.

a time interval t, then an event of the same type will not in general occur at any subinterval of t. Thus the event is associated with a unique time interval, giving rise to what Cooper calls **temporal groundedness**. We will adopt the temporal ungroundedness (TU) / temporal groundedness (TG) terminology to distinguish in what follows between states and processes on the one hand and CPs, culminations and points on the other.

Before giving the definitions, however, we need to consider the following point. It seems mistaken to consider an event "in itself" as being of type TU or TG. If we consider events as somehow pre-existing in the world as entities prior to individuation and description by an agent, then we run into problems. Consider, for example, a scenario or "event" where John runs a certain distance and stops when he reaches a shop. It is possible to describe this occurrence or happening in many different ways, including 'John ran' and 'John ran to the shop'. But if we describe it the former way it is of type TU and if we describe it the latter way it is of type TG. Another example is an event involving John eating apples. It is possible to describe the "same event" as 'John ate apples', or 'John ate some apples', or 'John ate three apples'. Yet the first of these described events is TU, whereas the latter two are TG. Clearly the distinction cannot lie in intrinsic, objective, speaker-independent features of the event itself, but rather in the way that the event is individuated and described by the speaker. The TU/TG distinction is therefore a reflection of the speaker's choice of how to describe the event.

It is for this reason that Krifka (1992) chose to classify not events but what he calls event predicates (which we would call types of event in our terminology). We get around this here by classifying **infons** as TU/TG. We then say that if a situation S supports an infon σ of type TG (say), where:

$S, \sigma : \mathrm{KEY}_0$

then S is classified as being of type TG. Thus, by claiming that a situation S is of type σ where σ is of type TG and the type KEY_0 holds, a speaker is classifying S as TG. In other words, the TG property of S is imposed by virtue of the classification of S as of type σ. No claim is being made about any objective, speaker-independent properties of S.

Let us first try to define what we are calling TU using the Bennett and Partee notion. Thus we define TU (for an infon) as follows:

Preliminary definition of TU for an infon:

$$\forall\sigma(T)\ [\sigma(T) : \mathrm{TU}\ \text{ iff }\ [\forall S\ \forall T' \sqsubseteq T\ [S \models \sigma(T')]]]$$

where the notation $\sigma(T)$ is used (as earlier) to mean that T is the time argument of infon σ.

We saw above that if σ:TU and σ is the key infon of S, then S:TU. We can spell out what S:TU means (for S of type EVY) as follows:

Preliminary definition of TU for a situation:

$$\forall S\ [S : \mathrm{TU}\ \text{ iff }\ [\forall\sigma(T)\ [S \models \sigma(T) \rightarrow \forall T' \sqsubseteq T\ [S \models \sigma(T')]]]]$$

There are problems with this kind of definition for temporal ungroundedness / homogeneity that have often been raised in the literature. One is that of "minimal parts". It may be argued that if the subintervals become sufficiently small, it is no longer correct to say that a subinterval corresponds to an event of type 'Daniel runs', but corresponds instead to something like 'Daniel raises his right foot'. If we believe this to be the case, it becomes necessary to put some restriction on how small we allow the intervals (or sub-events) to get.

Another problem is that of "interruptions". It may be argued that it is perfectly reasonable to use the sentence:

(5.5) Daniel played football for three hours

to describe a situation where Daniel takes several short breaks during his long session of football-playing. Cooper's definition of temporal ungroundedness, which we mentioned above, was put forward in order to overcome this problem (Cooper 1985). As we saw above, this involves introducing existential rather than universal quantification into the definition of TU. If we translate this into our formalism, we get:

Final definition of TU for an infon:

$$\forall \sigma(T)\ [\sigma(T) : \mathrm{TU}\ \text{ iff }\ [\forall S\ [S \models \sigma(T) \rightarrow \exists T' \sqsubseteq T \text{ s.t. } S \models \sigma(T')]]]$$

The corresponding definition of TU for situations of type EVY is then:

Final definition of TU for a situation:

$$\forall S\ [S : \mathrm{TU}\ \text{ iff }\ [\forall \sigma(T)\ [S \models \sigma(T) \rightarrow \exists T' \sqsubseteq T \text{ s.t. } S \models \sigma(T')]]]$$

This definition also gets around the minimal parts problem. We will therefore use it as our definition of TU.

Another way we can get round the minimal parts problem is to use the notions **cumulative** and **quantized** employed by Krifka (1992). Krifka applies these notions to both "object predicates" (e.g. 'apples', 'an apple') and "event predicates" (e.g. 'eat apples', 'eat an apple'). According to Krifka's definition, the object predicate 'apples' is cumulative (CUM) because whenever there are two entities of which 'apples' may be predicated, the predicate also applies to their collection. Similarly for events: if there two events of which 'eat apples' may be predicated, then this predicate also applies to the combination of these two events. Predicates like 'an apple' and 'eat an apple' are quantized (QUA), which means that the predicate does not apply to combinations of the objects/events in this way. The object formed by combining one apple with another apple may not be described as 'an apple', for example. Thus cumulativity for events is a similar notion to homogeneity, but instead of looking at sub-parts of events it is concerned with what happens when events are "added together" to form larger events. If we think of event predicates as event types in our terminology, we can speak of having an event of a given type, and a second event of the same type. Now we combine them to produce a third event. If the third event is of the same type as the other two, then the event type in question has the property CUM.

For example, an event of type 'John ran', when added to another event of type 'John ran', gives a third event of type 'John ran': thus the event type 'John ran' is cumulative. On the other hand, an event of type 'John ate an apple', when combined with a second event of type 'John ate an apple', does not give an event of type 'John ate an apple', but is rather an event of the type 'John ate two apples'. The event type 'John ate an apple' is thus QUA.[9]

Let us try to formalise this in situation theoretic terms. We take events to correspond to situations and event types to infons. Thus we can say that an infon σ has the property CUM if the following holds:

Definition:

$$\forall S_1, S_2\ [S_1 \models \sigma \ \&\ S_2 \models \sigma \rightarrow S_3 \models \sigma]$$

where S_3 is the situation formed by combining S_1 and S_2.

But using the traditional definition for adding situations (see, for example, Barwise and Etchemendy 1990), S_3 must support (at least) all the infons supported by S_1 and S_2 individually. Thus $S_3 \models \sigma$ unavoidably, irrespective of whether or not σ is cumulative. This problem is not necessarily insuperable, but in order to avoid the ensuing complications we will continue to use our original definition of TU for infons. We will, however, use the notion of cumulativity for objects.

We will now define TG for an infon, as follows:

Definition of TG for an infon:

$$\forall \sigma(T)\ [\sigma(T) : \text{TG iff } [[S \models \sigma(T) \rightarrow \exists T' \sqsubseteq T \text{ s.t. } S \models \sigma(T')] \\ \rightarrow T' = T]]$$

Just as we did for the TU case, we will say that if σ is the key infon of an eventuality S, and σ:TG, then S:TG. We characterise TG for situations as follows:

Definition of TG for a situation:

$$\forall S\ [S : \text{TG iff } [\forall \sigma(T)\ [[S \models \sigma(T) \rightarrow \exists T' \sqsubseteq T \text{ s.t. } S \models \sigma(T')] \\ \rightarrow T' = T]]]$$

We have now given a formal definition of the TU/TG distinction. Given that TU covers states and processes, and TG covers CPs and culminations, it is still necessary to formalize the STATE/PROCESS and CP/CULMINATION distinctions.

[9]To be precise, Krifka defines the property 'strictly cumulative' — SCUM — which is both cumulative and non-singular. It is −SCUM that corresponds to QUA. For simplicity we will use 'CUM' to refer to the property that Krifka calls 'SCUM'.

We will leave aside the STATE/PROCESS distinction here (see Glasbey 1994a for discussion).

Let us now consider how to express the CP/CULMINATION distinction. The simplest way to distinguish between CPs and culminations is in terms of their temporal duration. CPs are temporally-extended and culminations are instantaneous. We are not necessarily claiming that any eventuality is "really" instantaneous. This property is, rather a reflection of the way a speaker chooses to classify an eventuality, by describing it in a certain way. We will introduce a unary type INST which holds of an eventuality classified as instantaneous.

Definition:

$$\forall S, T\ [S : \text{INST}\ \&\ S, T : \text{TIME-OF}\ \rightarrow\ T : \text{INSTANT}]$$

where INSTANT is a type of times which holds of a time which is instantaneous (thus we need both instants and intervals in our temporal ontology).

We will say that if a situation S is of type TG and is also of type INST, then S is of type CULMIN (i.e., a culmination).

5.3.2 Representation of events and their times

We will digress briefly here on the subject of eventualities and their times, looking in particular at the differences between processes and CPs in the way that we describe the event as being related to a time.

Many have observed that processes can readily receive what is called an inceptive reading. Thus a sentence like:

(5.6) Daniel ran

is thought of as having two readings, the inceptive one which concerns the beginning of the process and the non-inceptive one which concerns the whole process.

This means that:

(5.7) Daniel ran at 2pm

is felicitous if we take the inceptive reading of 'Daniel ran', i.e. if we take the statement to mean that the running event commenced at 2pm. By contrast:

(5.8) Daniel climbed Ben Nevis at 2pm

is not so acceptable. However, we saw in Chapter 3, Section 3.5.2 that some CPs are exceptional in this respect — for example:

(5.9) We will eat dinner at 7pm

so the matter is not entirely clearcut. The exceptions seemed to involve CPs where some kind of scheduled event like a lecture a meal was involved.

In general, however, processes combine much more readily than CPs with 'at'-adverbials. Another example is:

(5.10) We sailed at 7pm

which sounds much better than:

(5.11) We sailed across the Channel at 7pm

We can explain the oddness of (5.8) and (5.11) if we take 'at'-adverbials to modify events which are described as (at least approximately) instantaneous. Then, in order to explain why (5.7) and (5.10) are acceptable, we need to say something to the effect that these sentences describe the beginnings of the relevant events.

Why should it be that sentences describing processes can readily be given inceptive interpretations, whereas sentences describing culminated processes in general cannot? Suppose we were to say that "a process sentence always describes the beginning of an event". But this seems clearly wrong. We pointed out above that process sentences can describe **either** beginnings or the process as a whole.

One possibility is to say that an utterance of (5.6) describes only the beginning of Daniel's run, and that we infer the rest. Of course we don't need to infer that there was very much more in the way of running. It's possible to say:

(5.12) Daniel ran, but almost immediately he tripped and fell

But it seems that we need to infer that at least some running took place. It sounds rather odd if we say:

(5.13) Daniel ran, but before he actually ran, he tripped and fell

Compare:

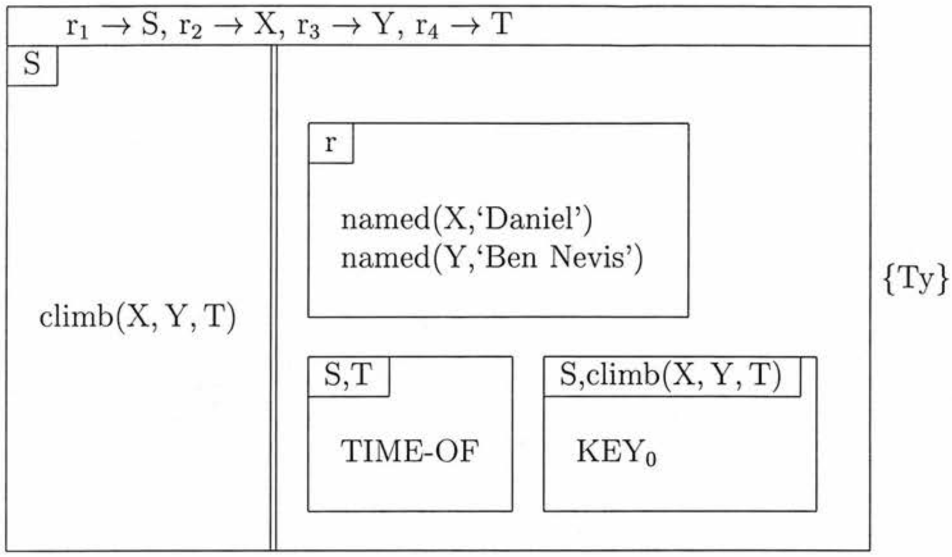
(5.14) Daniel started to run, but before he actually ran, he tripped and fell

which sounds much better than (5.13).[10]

So it seems as though some running is definitely entailed by an utterance of (5.6). One way to capture the contrast between (5.13) and (5.14) is to say that (5.13) describes a situation of type **run(daniel)** while (5.14) describes only the beginning of such a situation (an "initial slice" of it). We could capture the fact that (5.6) readily has an inceptive reading by saying that an utterance of (5.6) refers to the whole event (of type **run(daniel)**), but **focuses** upon the beginning of it. Of course, this requires us to define precisely what we mean by focusing on a particular part of an event. We will now develop a way to formalize this notion.

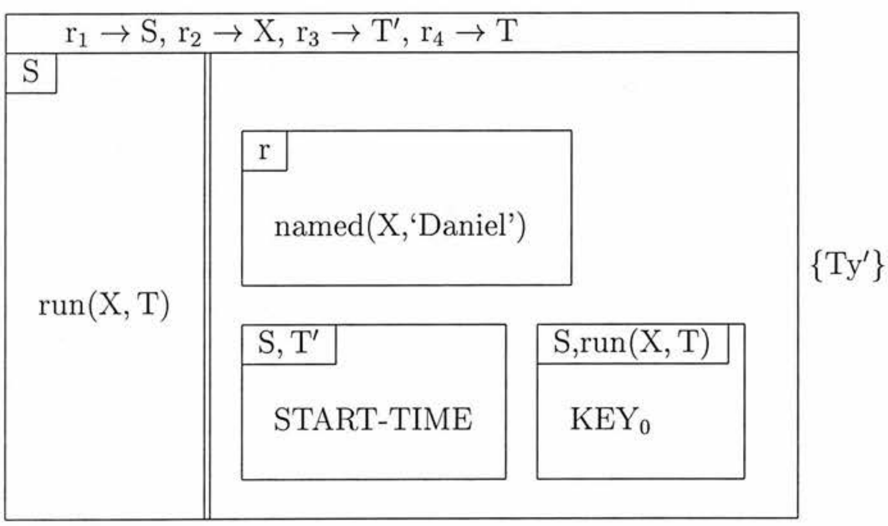
First, consider the type Ty below:

[10] We are not attempting to develop a theory of inceptives here. See (Mellor 1993) for an account of these.



So an utterance of 'Daniel climbed Ben Nevis' classifies a situation, two individuals and a time interval as being related in the above way. (We will take the resource situation r as some kind of given here.)

Now consider the type Ty', corresponding to an utterance of 'Daniel ran':



Here, note that the parameter T' is the start-time of S.

Thus we are claiming that the sentence 'Daniel ran' relates a situation and the time at which that situation begins. The sentence 'Daniel climbed Ben Nevis', on the other hand, is about a situation, and its occurrence-time. This helps explain why 'Daniel ran' can be interpreted as describing either the beginning of a run or a complete run, while these don't seem to constitute distinct readings. It also explains why, in (5.15):

(5.15) Daniel ran at 2pm

'at 2pm' must refer to the start time of the running event. It can't refer to any arbitrary time during the event. Compare the progressive:

(5.16) Daniel was running at 2pm

where 'at 2pm' can refer to a time during the event (but *not* the beginning time) and the stative:

(5.17) Daniel was happy at 2pm

where 'at 2pm' can specify either the starting time or some time during the state of happiness. (See Glasbey 1994a for a discussion of statives and progressives.)

We can now explain why process sentences can readily combine with 'at'-adverbials, even when the described situation cannot readily be seen as happening in a very short time. E.g:

(5.18) Mary played tennis at 2pm

sounds fine. Compare:

(5.19) Mary played three sets against Sally at 2pm

which sounds rather odd. I.e., it seems natural to use an 'at'-adverbial to specify the start-time of a process, but much less so to use an 'at'-adverbial to specify the start-time of a CP. Also, compare:

(5.20) John chopped onions at 11am

which sounds fine, and can be followed by:

(5.21) He chopped two dozen of them

with:

(5.22) John chopped two dozen onions at 11am

which sounds very odd.

However, there are some interesting exceptions to this, as mentioned above. For example:

(5.23) Professor Smith gave the lecture at 2pm

followed by:

(5.24) It lasted two hours

sounds fine. So does:

(5.25) We ate dinner at 7pm

followed by:

(5.26) It was a five course meal

But compare:

(5.27) We ate a five course meal at 7pm

which is considerably less good.

Why is this? One possibility is that (5.23) and (5.25) are describing processes here. Perhaps some kind of coercion of CPs to processes is taking place. However, if this were the case, we would expect (5.23) and (5.25) to combine readily with 'for'-adverbials. But note that the following sound odd (at least to some speakers):

(5.28) We ate dinner for two hours

and:

(5.29) Professor Smith gave the lecture for two hours

So it seems that (5.23) and (5.25) are probably not describing processes, and we must look for an alternative explanation.[11] Another possibility is to say that (for some reason) 'eat dinner' and 'give the lecture' describe types which are naturally associated with both start-times and occurrence-times. Perhaps there is something about the nature of these types of events which allow us to readily associate them with their start-times. This seems intuitively reasonable. Meals and lectures are both events which we naturally think of as happening at set, predetermined times, which are particularly salient to the event. It is almost as though (5.23) could be paraphrased:

(5.30) Professor Smith gave the lecture, starting at 2pm

[11] Readiness of combination with 'for'-adverbials is a standard test for processes, in the literature. See (Dowty 1979), for example.

This is not true for CPs in general, however. We do not readily associate most CPs with their start-times, and the combination of a CP and an 'at'-adverbial sounds odd unless the CP is one of very short occurrence-time. By contrast, we generally do associate processes with their start-times, and thus processes combine readily with 'at'-adverbials no matter how long the duration of the process. This makes sense given that we do not naturally associate a process with its occurrence time, as a process has no predetermined endpoint or culmination.

So it appears that, in general, PROCESS situations together with their start-times form "objects of description", as do CP situations together with their occurrence-times. And we might say that an utterance "presents" a situation, a time and various individuals, and says how these are related. The situation is a "real one" (the run actually happened — it's not like the progressive where we need some conceptual situation that didn't necessarily go to completion) but this formalism give us a means to mirror what a process sentence does, that is, to focus on the beginning of the situation.

5.3.3 Formalising the nucleus model for events

An important distinction is made in situation theory between the information that a situation **supports** and the information that it **carries**. See (Barwise 1989, p.51ff), for example. In the discussion that follows, we will use the more recent terminology of Barwise and Seligman (in press).

Barwise and Seligman speak of the "natural regularities" perceived by agents in the world around them and used to enable them to reason with limited information. Natural regularities correspond to what we might say is "normal" or "expected". An important point about reasoning with such regularities or "constraints" is that in particular cases it may fail. Constraints are in sense approximations to reality. Exceptions to a particlar regularity may exist, with the result that we sometimes reason wrongly. In general, however, they are reliable enough for us to use them to interact successfully with our environment.

An example given by Barwise and Seligman is the regularity that exists between situations of a type where the doorbell rings, and situations of a type where someone is standing on the porch. In general, this will be reliable, and we will usually be right if we infer on hearing the doorbell ring that someone is standing on the porch. Occasionally, however, things will go wrong and a false conclusion will be drawn. The bell may be faulty, for example, or a falling branch may have hit it and caused it to ring. But the existence of such exceptions does not invalidate the general usefulness of the a constraint.

Barwise and Seligman capture the usefulness and fallibility of constraints by introducing **channels** that work on two levels — the level of tokens and the level of types. Tokens may be, for example, situations, but they are not limited to these and may be any kind of object. If the tokens are situations, then the types are situation-types. Types are linked by constraints, denoted as follows:

$\phi \Rightarrow_c \psi$

where $\Rightarrow$ is pronounced 'indicates'. The subscript 'c' is to show that the constraint involves a particular channel, c.

Tokens are linked by connections, e.g:

$S_1 \rightarrow_c S_2$

where in this example S_1 is said to 'signal' S_2.

A given channel c contains a number of connections and a number of constraints, and determines which connections are of the type of which constraints. E.g. c may tell us that

$S_1 \rightarrow_c S_2 :_c \phi \Rightarrow_c \psi$

There is a soundness condition which says that if $S_1 : \phi$ and the information link between S_1 and S_2 is of type:

$\phi \Rightarrow_c \psi$

then $S_2 : \psi$

The soundness condition guarantees that if the connection between S_1 and S_2 is of the correct type, then S_2 will be of type ψ. Thus, by virtue of the channel c, S_1 carries information about S_2. If the connection is not of the expected type, then no information about S_2 can be inferred by virtue of this channel. This would be the case in the example we discussed above where the doorbell is faulty — the connection is an 'exception to the regularity' in this case.

In some cases, there are no exceptions to the regularity, and the constraint is said to be an "absolute" one. Absolute constraints will be useful to us in our account of event structure below.

Situation theory speaks of agents being "attuned" to constraints. For example, an agent attuned to the above constraint and aware of a situation S_1 of type ϕ can infer the existence of a situation S_2 of type ψ.

Now let us consider how to apply these notions to event structure. Suppose we have an utterance of:

(5.31) Daniel climbed Ben Nevis

We proposed above that this utterance describes a situation S_d, which supports an infon σ, where σ:CP. We said, too, that if S_d:EVY and S_d, σ : KEY$_0$, then S_d:CP.

Now it seems that by virtue of describing S_d, the utterance also **carries** information about some other situations. These are:

- A situation S_p (corresponding to the preparatory process) which is part of S_d. This corresponds to the climb minus its culmination. It seems natural to think of S_p as part of S_d, i.e. $S_p \trianglelefteq S_d$.

  It is useful at this point to define a relation between situation which encompasses the PART-OF relation but also requires a relation of (improper) temporal inclusion.

  Perhaps it is difficult to conceive of a situation S' that we would want to consider as PART-OF a situation S without S' being temporally included in S. However, there does not seem to be any reason to rule out the possibility in principle, so for this reason we will introduce a new version of $\trianglelefteq$ which is a binary type of situations of type EVY. We will call this relation $\trianglelefteq_{sl}$ (pronounced 'slice-of', and define it as follows:

  Definition:

For any two eventualities S and S' of type EVY:
$S' \trianglelefteq_{sl} S$ iff $S' \trianglelefteq S$ (traditional PART-OF), and: $T' \sqsubseteq_T T$ (where T, T' are the occurrence-times of S, S' respectively and $\sqsubseteq_T$ conveys temporal inclusion.

Now, because S_p is temporally included in S_d, we can say that:

$S_p \trianglelefteq_{sl} S_d$

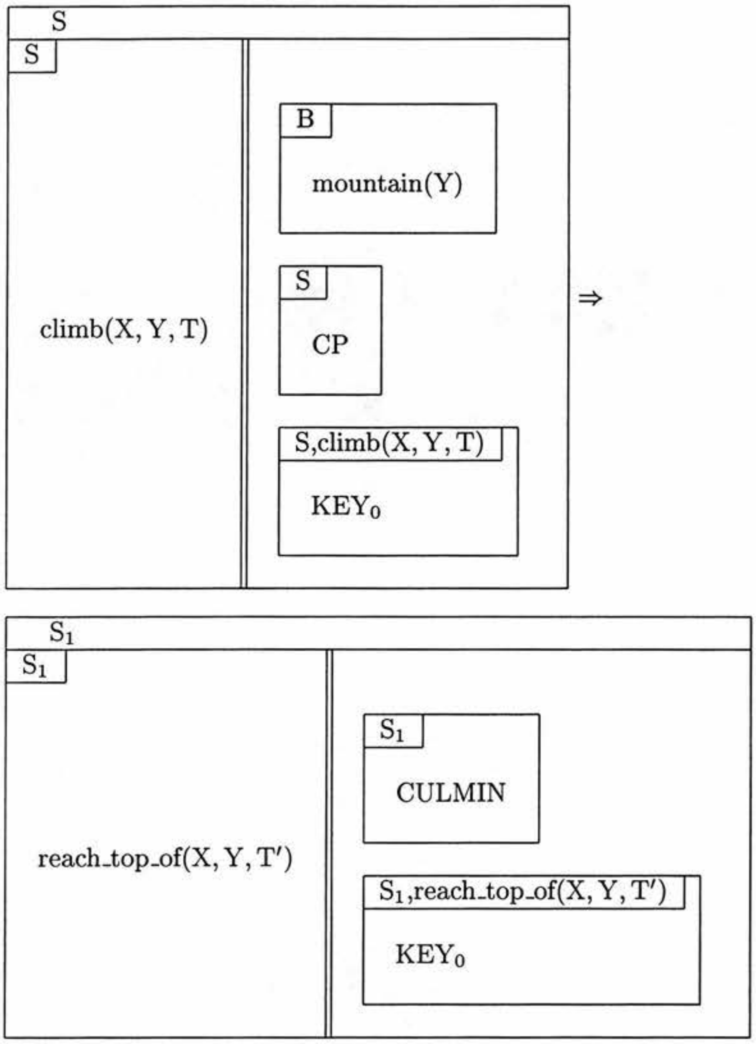
- A situation S_{cu} corresponding to the culmination of S_d. S_{cu} is the situation we could call "reaching the top of Ben Nevis". Again, it seems appropriate to consider S_{cu} to be part of S_d, and because S_d temporally includes S_{cu}, we can say that:

  $S_{cu} \trianglelefteq_{sl} S_d$

- A situation S_{co}, which corresponds to the consequent state of climbing Ben Nevis.[12] In contrast to the cases of S_p and S_{cu}, we will say that S_{co} is **not** a slice of S_d. This is because S_{co} is not temporally included in S_d. Indeed, it seems that we do not want to say that $S_{co} \trianglelefteq S_d$, either. Aside from temporal considerations, it is possible in principle to perceive S_{co} without perceiving S_d (i.e., to perceive the consequences without perceiving the event). Arguments like this involving the intuition that situations are parts of the world that we can perceive were used in early work on situation semantics (Barwise 1981, Barwise and Perry 1983) and in more recent work such as (Cooper 1991).

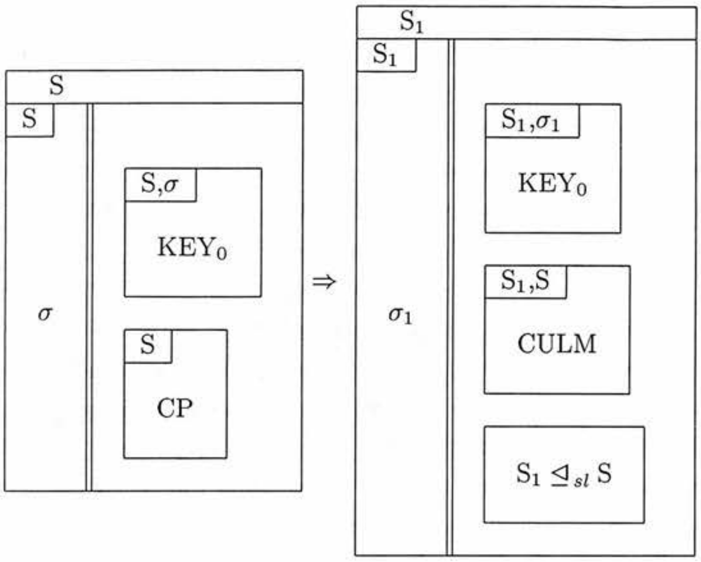
We propose that the above information is carried by virtue of constraints between situation-types. We suggest the constraint:

[12]We might want to call this the state of having climbed Ben Nevis. Of course it is possible to think of the same event having a number of different consequences. One consequence might be that Daniel is tired, for example. Another might be that he is happy. However, each of these consequences may be of limited duration. We prefer the notion of a consequent state that is simple the state of "Daniel having climbed Ben Nevis" — a state that must hold forever. This is not to say that other notions of consequent state could not be built into our account.



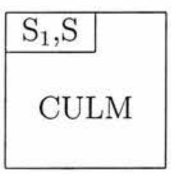
which says that a situation where someone climbs a mountain indicates another situation where that person reaches the top of the mountain.

We might express this kind of constraint more generally as follows:

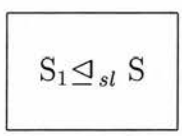


In words, for any situation, infon pair S, σ where σ is the key infon of S and $S and \sigma$ are of type CP, S signals a situation S_1, where S_1 is the culmination of S.

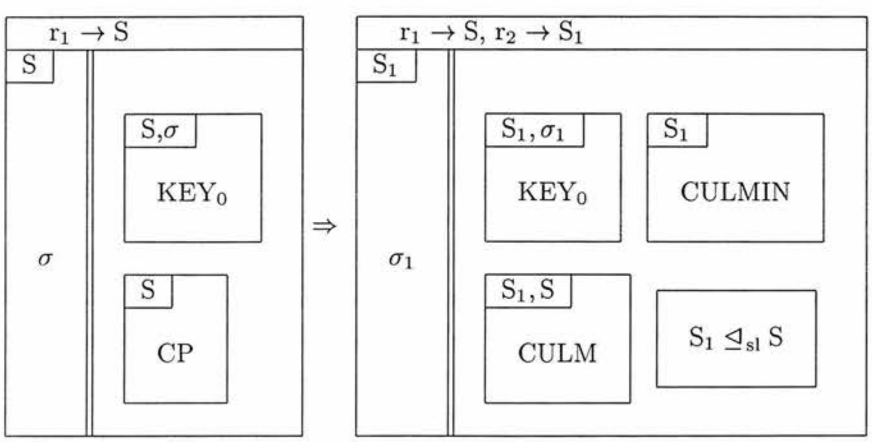
This constraint raises a problem, however. The problem lies in the restricting propositions:



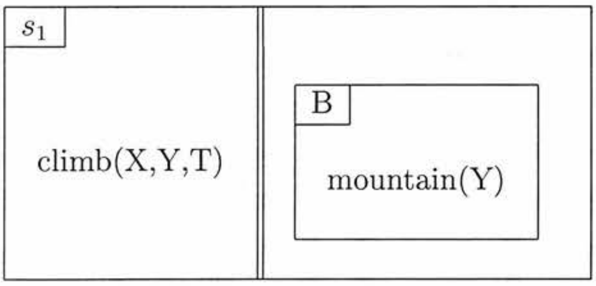
and



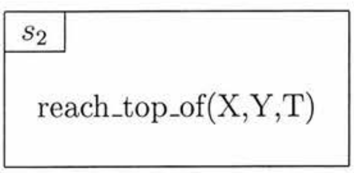
In order to form the constraint, we have abstracted over the parameters S and S_1. But once we have done this, it does not make any sense to express restrictions concerning these parameters. One way round this problem is to express the constraint as follows:



We will call the above constraint c_1. Now it appears that c_1 holds without exception — it is what Barwise and Seligman call an **absolute** constraint. That is, any and every situation of the former type (which we will call ϕ) conveys the information that there is a situation of the latter type (which we will call ψ). We can capture this by saying that a situation of type ϕ is a **signal** for a situation of type ψ. Thus, for example, S_1 is a signal for S_2, where:



is true, and



.

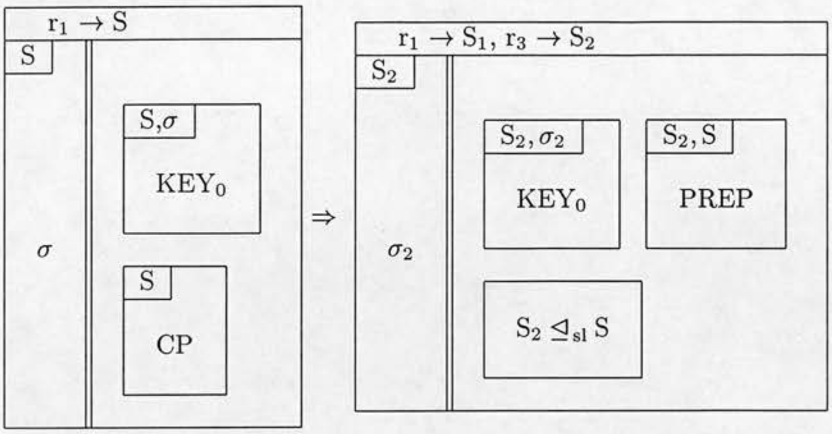
is true.

More generally, we can say that any situation of type S is a signal for a situation of type S', by virtue of c_1.

In c_1, because S_1 is a slice of S, we will say that S_1 has the status of **described** information. This means that, in the example above, even though S_2 is not "directly" described by (5.31) but is inferred from it by virtue of c_1, the fact that S_2 is a slice of of S_1 means that a description of S_1 effectively "encompasses" S_2, and S_2 is thereby **described**.

Let us define a similar constraint c_2 concerning preparatory processes.

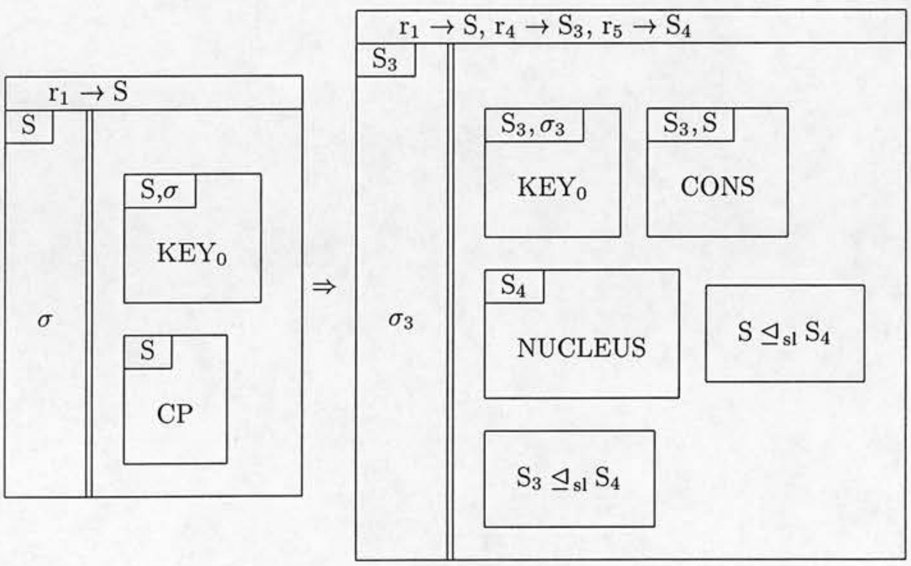
Definition of c_2



Here again, we decided earlier that S_2 should be thought of as part of S. Thus, S_2, like S_1, has the status of **described** rather than merely **inferred** information. Once again, the constraint is an absolute one.

Now let us introduce a constraint c_3 to deal with the consequent state.

(c_3)



Here, as explained above, we do not wish to regard S_3 as part of S, but rather we see both S and S_3 as part of some larger situation S_4 (of type NUCLEUS). Because S_3 is not part of S, we do not give it the status of described information. The information about S_3 is inferred rather than described.[13]

[13] Another possibility is to make CONS a relation rather than a type. Thus the fact that

The constraint c_3 is like c_1 and c_2 in that it is absolute.

We also need to express the fact that we can infer a CP from the description of a culmination, using a similar kind of constraint. Note that the culmination is a temporal slice of the inferred CP, but not the other way round. Thus, in inferring a CP from a culmination, the CP will not have the status of described information. The CP is merely inferrred. This will be useful to us in the following section, when we look at culminations and 'for'-adverbials.

We do not claim to have given here all the possible constraints between parts of an event. We have presented a number of these in order to show how they capture the reasoning we may perform on the basis of linguistic information.

We have shown how choosing to model eventualities as situations allows us to formalize in situation-theoretic terms the nucleus structure of events developed in (Moens 1987). Constraints between situation-types allow us to tie together the various components of a Moens event nucleus. However, one important point to which we have not paid much attention is that Moens argues that the nucleus is held together not merely by temporal relations but by relations of contingency and causality, and it is important that our treatment should ultimately capture this. There seems to be no reason why this could not be done in the kind of theory we have been using.

We will now show that the ST distinction between described and inferred information enables us to capture the behaviour of the various tense/aspect constructions with temporal adverbials. We will look at some constructions with 'for'- and 'in'-adverbials that do not seem to be fully explained by Moens' transition network, and show how the above distinction can provide us with a more complete account.

one situation is a consequence of another would be seen as "situated"—i.e., supported by some situation or other. This seems a reasonable way of capturing the idea that the relationship between an event and its "consequences" is at least to some extent a matter of perspective, or point of view of the speaker, rather than being a matter determined by the way the world is. However, it is not clear to us exactly which situation would support facts containing the CONS relation. I leave this open as a matter for further consideration. The same comment might apply to the PREP relation too.

5.3.4 Culminations, 'for'- and 'in'-adverbials

Consider the following sentences involving culminations:

(5.32) ??John reached the top for four hours

(5.33) John reached the top in four hours

(5.34) ??John was reaching the top for four hours

We require an explanation for the oddness of (5.32) and (5.34). According to (Moens 1987), a 'for'-adverbial can only combine with a process. In the case of (5.32), one possible route through the transition network is to coerce the culmination to a CP, followed by coercion of the CP to a process, which can then combine with the FOR-adverbial. Moens' explanation of why this is not possible for (5.32) involves specifying that the transition:

CP $\rightarrow$ PROCESS

is only possible in English when progressive aspect is present.

However, this does not explain why:

(5.35) Daniel climbed Ben Nevis for four hours

although not generally judged completely acceptable, is nevertheless agreed to be much better than (5.32). There are other similar examples like:

(5.36) Mary played the sonata for a few minutes which sounds acceptable even though 'play the sonata' is normally thought of as a CP (it combines readily with 'in'-adverbials, for example). Another acceptable example is:

(5.37) John read a book for a few hours

although, again, 'read a book' behaves in other ways as a CP. Compare, however:

(5.38) ??Sally built a house for several days

which sounds extremely odd. It is interesting to consider why some CPs can readily be modified by 'for'-adverbials while some cannot. There appears to be a whole range of acceptability here, as well as considerable differences between intuitions among speakers. One possible line of explanation would be to say that some expressions, such as 'play a sonata', can be used to describe both CPs and processes, depending upon the context. Others, such as 'build a house', can only ever be used to describe CPs. There is some intuitive motivation for this. Playing a sonata properly involves lots of practice, and it is easy to envisage the instrumentalist playing half a movement, stopping, going over a difficult passage several times, and then giving up on the first movement and beginning on the second. Now compare building a house. Although house-building can also go on in fits and starts, and most kinds of houses can't be built all in one go, it is nevertheless hard to imagine stopping and going back to build the same bit several times over (we are not saying this could never happen. An inexperienced builder might well find herself making several attempts to fix the ceiling beams, say. But, somehow, this going over the same bit again is not part of our general conception of what it means to build a house in the same way as it is to play a sonata). What can we say about reading a book? Here again, our world knowledge tells us that it is quite usual to read the same passage more than once, to miss out chunks, to skip backwards and forwards and to have a quick look to see how it ends. Perhaps this notion of what it means (or can easily mean) to read a book is related to the fact that 'read a book' can readily be used as a process expresson.

These suggestions are very speculative, but it seems clear that our general world knowledge is playing an important part here. Perhaps an account could be developed that explains how our knowledge of "typical scenarios" for events affects whether it is possible to use an expression that is normally used to describe CPs to describe a process. We will not consider this further here.

Moens' network also predicts that (5.34) will be acceptable — whereas in fact it sounds extremely odd. Intuitively, the reason for this is that it sounds as though Daniel took a very long time to reach the top — as though for some reason the final stage of the climb was extremely slow. If we make the duration shorter:

(5.39) Daniel was reaching the top for two minutes

this seems to improve things to some extent, although this sentence still sounds rather peculiar.

But the important point to note is, as we said above, that the time adverbial seems to specify the duration of some final stage of the climb, not of the climbing process as a whole. The transitions allowed by the network:

CULM $\rightarrow$ CP $\rightarrow$ PROCESS

suggest that (5.34) can refer to the whole of the preparatory process, but if that were the case then (5.34) should not sound odd at all, given that it is quite reasonably for the preparatory process, the 'climbing', to have a duration of four hours or more.

Also, if:

(5.40) Daniel was reaching the top

referred to the preparatory process as a whole, or an arbitrary part of it, then we would expect:

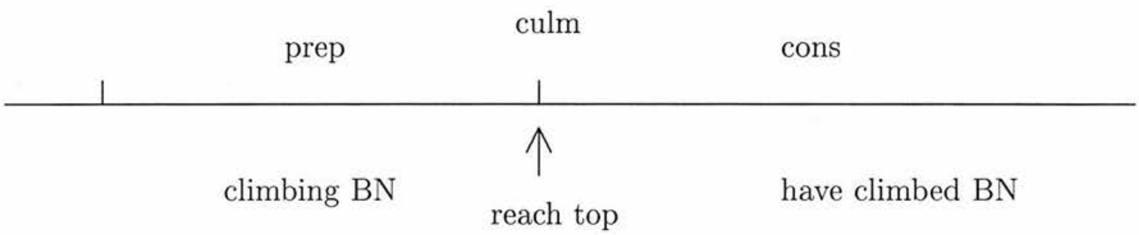
(5.41) Daniel was reaching the top when it started to rain to be appropriate as long as the rain started some time during the climb. However, (5.41) must mean that the rain started at some late stage of the climb, when Daniel was near the top.

Yet, by contrast, (5.33) shows that where an 'in'-adverbial is present, this refers to the CP as a whole and not to some final part of it.

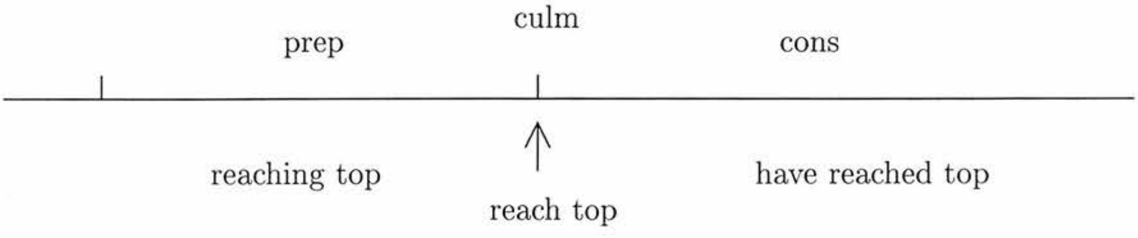
So why can't the 'for'-adverbial in (5.34) refer to the duration of the whole of the preparatory process? It seems that we are forced, in interpreting (5.34), to see 'reach the top' as a CP "in its own right", with its own associated preparatory process that comprises the "last bit of the climb". What we cannot do is to interpret the progressive + culmination as referring to the preparatory process corresponding to "climb Ben Nevis".

Moens' account is able to explain the existence of the two alternatives, by allowing the **core event** to be taken as either (i) 'climb Ben Nevis' or (ii) 'reach the top of Ben Nevis'. (Moens uses the idea of being able to choose among alternative core events in his account of 'when'.)

If (i) is chosen, the nucleus is:



If (ii) is the core event, the nucleus is:



where presumably the 'prep' of (ii) is a short period that can be seen as the preparatory process to 'reaching the top' i.e. it is not the whole climb, but the last bit of it. So Moens' account predicts that the two interpretations are possible, and also why (5.34) interpreted according to nucleus (ii) sounds rather odd (because it is difficult to envisage a preparatory process 'reaching the top' lasting four hours — indeed perhaps it is difficult to envisage the preparatory process 'reaching the top' having any significant duration at all).

But Moens does not explain why (5.34) can be associated with nucleus (ii) but not nucleus (i).

We suggest that what is important is the difference between information that is described by an utterance, and information that is inferred from the content of an utterance by virtue of constraints. We described these in the previous section as **described** and **inferred** (or **carried**) information, respectively. We saw that a culmination **carries** information about an associated preparatory process, but it does not **describe** the preparatory process. In contrast, a CP describes both the culmination and the preparatory process.

Suppose we say that a 'for'-adverbial is restricted to specifying the duration of **described information**. Then we can explain why, in (5.34), the 'for four hours' must refer to the last bit of the climb. The preparatory process is inferred, not described. We have just said that a 'for'-adverbial is restricted to specifying the duration of a **described** situation. Thus the 'for'-adverbial forces us to see 'was reaching the top' as described information. We can only do this if manage to see 'reach the top' describing a CP, i.e. it becomes a CP "in its own right". The progressive appears to help us to do this — it somehow "stretches" the event and allows us to read it as a CP. Work on the progressive combined with culminations that involves similar notions has been carried out by Mellor (1993). Without the progressive, this "stretching" of a culmination to a CP is not possible. This explains why (5.32) can't mean the same as (5.34) and why (5.34) has to be interpreted according to nucleus (ii), and consequently has to mean that the last stage of the climb, not the whole climb, had a duration of four hours.

In contrast, 'in'-adverbials are able to modify **inferred** information. Thus we can interpret (5.33) (indeed we must interpret it) according to nucleus (i). An 'in'-adverbial can refer to either a described CP, as in:

(5.42) Daniel climbed Ben Nevis in five hours

or to an inferred CP, as in (5.34).

Thus the distinction between described and inferred information gives us a way to explain these facts about the distribution of 'for'- and 'in'- adverbials.[14]

The distinction between described and inferred information might provide a way of formalising Moens' notion of "focusing" on different parts of the nucleus. Moens (1987) (page 45) explains that his notion of "stripping off a culmination" from a CP to give a preparatory process (which appears to involve deletion of information) is actually a shorthand way of talking about a "shift in focus" from one part of the meaning complex to another. Thus, he maintains that the meaning is not lost — we retain the information that an event like "climb a mountain" has a natural endpoint, even though we cease to focus on this endpoint when we apply the progressive. However, Moens does not define 'focus' or 'shift in focus', evocative as these terms may be. It is necessary to define these terms if the explanation is to be a satisfactory one.

Thus the ST distinction between described and carried information helps to explain "focus" and "shift in focus" — the situation **described** by a given sentence being the part of the event that is in focus at the point in the discourse immediately after it is uttered.

5.3.5 Summary

In this section we have investigated a way of formalising events and their structure, using situation theory. We began by showing how to distinguish between the various aspectual classes in situation-theoretic terms. We then showed how Moens' nucleus model of event structure (Moens 1987) may be expressed formally in situation-theoretic terms using the notions of constraints and channels. These allow a description of one phase of an eventuality to carry information about another related phase. Formalising things in this way enabled us to express Moens'

[14]Of course we are not attempting to give a complete account of the semantics of 'for'- and 'in'-adverbials here.

notion of "focusing" on a particular phase of an event to be precisely expressed. We were also able to use the distinction between information that it directly described by an utterance and information that is inferred by means of constraints to explain some observations about 'for'- and 'in'-adverbials and in particular the meanings conveyed by combinations of 'for'-adverbials, progressives and culminations.

In general, we have shown that using situations to model eventualities provides a fruitful way to express what has been learned over the past decade about the event structure needed for to formalise the semantics of aspectual class.

5.4 Aspectual Composition

5.4.1 Introduction

In this section, we will attempt to express in situation-theoretic terms some well-known observations about the contribution of subject and object NP referents to the aspectual properties of sentences. We will consider in more detail the accounts of aspectual modification/composition given by Moens (1987), Verkuyl (1989) and Krifka (1992), which we introduced in Section 5.2. We will compare these accounts and argue in favour of pursuing an information-preserving analysis along the lines of Krifka. We will spend some time investigating how Krifka's notion of properties of thematic roles and their influence on the interaction between properties of objects and properties of events may be expressed within our situation-theoretic framework.

As the motivation behind this work is to show how the grammar of Chapter 3 might be improved and extended, we will begin by attempting to formulate some lexical entries for verbs. We will then extend and modify these lexical entries as we develop situation-theoretic account of aspectual composition and write rules to capture the relevant interactions.

5.4.2 Lexical entries and compositional rules

We will use the formal account of event structure and aspectual class distinctions developed so far to write some lexical entries for verbs in a grammar extended from that of Chapter 3. We will restrict ourselves to deal with processes, CPs and culminations here.

We begin with the transitive 'climb'. Our lexical entry for 'climbed' in Chapter 3 was:

climbed:
(u, utt, ty, f, in, out):v
where ty is:

<table>
<tr><td colspan="2">[subj, u_1] → X, [obj, u_2] → Y, [pred, u] → R, [ev, u_3, utt] → S, [time, utt] → T</td></tr>
<tr><td>S

R(X,Y,T)</td><td><table><tr><td>S,R(X,Y,T)

KEY</td><td>S

EVENT</td></tr></table></td></tr>
</table>

if:

$[[\text{pred},u] \rightarrow \text{climb}] \subseteq f$

$$u \models \begin{bmatrix} \text{use-of:} & \text{`climbed'} \\ \text{cat:} & \{\text{v}\} \\ \text{trans:} & \text{pos} \\ \text{aspect:} & \text{simple} \\ \text{time-ref:} & \text{past} \end{bmatrix}$$

$$u_1 \models \begin{bmatrix} \text{cat:} & \{\ldots,\text{np}\} \end{bmatrix}$$

$$u_2 \models \begin{bmatrix} \text{cat:} & \{\ldots,\text{np}\} \end{bmatrix}$$

$$u_3 \models \begin{bmatrix} \text{ev-type:} & \text{event} \end{bmatrix}$$

$out = in \cup \{[\text{ev},u_3], [\text{time},utt]\}$.

The only aspectual information we gave here was to specify that the described situation is of type EVENT. We made no distinction between processes and CPs — i.e., we had no notion corresponding to TU/TG.

We now need to incorporate such information in the lexical entry. However, note that we cannot identify the described situation as TG or TU in the lexicon, because this depends on the nature of the subject and object arguments of 'climb'. What we need instead is to incorporate information in the lexical entry that tells us how the nature of the arguments help determine the TU/TG properties of the described eventuality.

We mentioned earlier Moens' approach to the effect of verbal arguments on aspectual class, using the notion of **coercion**. We also referred to the approaches of Verkuyl (1989) and Krifka (1992). We will now consider these approaches to aspectual composition/modification in more detail, and show how they could be incorporated into a grammar that is an extension of the one given in Chapter 3.

We discussed how in Moens' theory of aspectual modification by coercion, a verb is assigned a basic aspectual class[15], and object arguments and other constituents (together with non-linguistic factors such as context) may modify or **coerce** this type to another type, according to a set of permissible coercions which form an aspectual network. One of the permitted coercions is from the type PROCESS to the type CP. Such coercion may occur in the presence of an object NP, if the NP consists of a determiner plus a count noun. We discussed earlier our reservations about the non-monotonicity of this type of approach.

We mentioned, too, Verkuyl's argument that aspectual class does not exist at a syntactic level lower than VP. Instead of assigning a basic aspectual class to a verb, Verkuyl assigns various features to verbs and NPs. Verbs are classified as +/−ADD-TO (corresponding, very roughly, to a state/ non-state distinction). NPs are classified as +/− SQA where SQA stands for 'specified quantity of A' and is defined model-theoretically using generalised quantifier theory (Barwise and Cooper 1981). Verkuyl argues that if a +ADD-TO verb combines with a +SQA object, the resulting VP is of type **terminative** (equivalent to TG in our formalism). Any other combination results in a VP which is **durative** (i.e., non-terminative or TU). He also describes how the VP combines with the subject to

[15]**Basic aspectual type** in Moens' terminology.

determine the aspect of the whole sentence. Verkuyl's account attempts to be more explanatory than that of Moens, in that Verkuyl tries to capture model-theoretically the interaction between the properties of the verb and the properties of NP arguments. Moens, on the other hand, describes the influence of NP arguments on aspectual class by means of an arc on the aspectual network, but does not attempt to capture formally the mechanics of the interaction.

There is a strong intuitive appeal in the notion that what is intrinsic to a verb is some semantic property which influences how it combines with an NP (depending on some semantic property of the NP) — especially if the features are both intuitively motivated and can be given adequate model theoretic definitions. But Verkuyl's account suffers from another problem in that it does not distinguish between cases like 'climb a mountain' — where 'a mountain' (+SQA) combines with 'climb' (+ADD-TO) to give a terminative VP — and those like 'drive a car' where 'drive' is similarly +ADD-TO and 'a car' is +SQA, but the resultant VP is durative. What is missing in Verkuyl's account is a clear characterisation of the relationship between the verb and the argument in question. Intuitively, we want to say something to the effect that 'climb a mountain' involves a relation of "correspondence" between the climbing event and the mountain. As the event progresses, more and more of the mountain is gradually ascended. A similar and even more striking type of such correspondence is present in an event of type 'eat an apple'. As the event proceeds, the apple is gradually consumed. But there is no such correspondence in the case of 'drive a car'. Nothing intrinsic to the car can be measured that corresponds to the progress of the event. Of course, if we add 'to Glasgow' we get the graduality effect. We can now measure the position of the car relative to its destination, and see its distance from Glasgow as corresponding inversely to the progress of the event.

Krifka (1992) formalizes this notion of the relation between objects and events. He calls such a relation a 'thematic relation' and he defines various properties of such relations, such as **gradually-consumed patient, gradually-effected patient**, etc. He introduces algebraic lattices of events and objects and a mapping between them. Events and object predicates are both classified as CUM/QUA (cumulative/quantized). The mapping consists of a transfer of CUM/QUA properties between objects and events. The mapping is dependent upon the presence of a thematic relation of appropriate type between object argument and the corresponding event. Thus the distinction between 'drive a car' and 'climb a mountain' can be captured neatly by saying that the appropriate type of thematic relation is present in the latter case but not in the former.

Krifka's account is similar in some respects to Verkuyl's. Like Verkuyl, he does not employ a notion of basic aspectual class. In fact he does not use Vendler-like classes at all. He concentrates mainly on the notions of cumulativity and quantization. Krifka'a account is very adept at accounting for data from languages (e.g. Czech) where NPs are unspecified as regards the QUA property, but their interpretation is influenced by the perfective/imperfective nature of the verb use.

If we are interested in an information-preserving account then the "underspecified" approaches of Verkuyl and Krifka have an advantage over Moens' non-monotonic approach whereby information must be withdrawn or "overwritten".[16]

In addition, Krifka's thematic relations appear to be intuitively well-motivated and reasonably straightforward to express in theoretical terms. We will therefore use an approach to aspectual composition that is underspecified like that of Verkuyl and Krifka. However, we will continue to use Moens' theory of event structure in our characterisation of situations.

As explained in Section 5.3.1, we will use the CUM/QUA distinction for predicates of objects (such as 'apples' or 'an apple') and the TG/TU distinction for situation/infon pairs. We pointed out earlier that there are some problems with the CUM/QUA distinction involving predicates like 'some apples' which are are of type CUM but behave like QUA predicates. We will, however, ignore these problems in what follows. A discussion of the problems and a proposed solution is given in (White 1993).

We explained above that we don't want to commit ourselves in the lexical entry to whether S is of type TU or TG, as this will depend partly on, for example, the nature of the object argument.

Krifka (1992) expresses such information as follows. As we said above, he uses the notion of **thematic relation**, which is a relation between a particular object

[16]Note, however, that recent work by Mellor explores how Moens' account may be re-expressed in an HPSG format relying on the underspecification of information, in such a way as to capture Moens' insights without requiring the over-writing of information. See (Mellor 1993.)

and an event in which that object participates. Thus:

$\theta(e, x)$

where θ is the thematic relation that holds between event e and participant x. He then defines properties of θ such as **uniqeness of objects**, **uniqueness of events**, **mapping to objects** and **mapping to events** (see below). Such properties express information about how the object is related to the event, and are relevant to the determination of the aspectual properties of that event as described by a piece of language.

Rather than introduce thematic relations as objects into our situation theoretic formalism,[17] we will express what Krifka calls properties of thematic relations as binary types of events and individuals. Thus, instead of writing:

$\theta(e, x)$

and then ascribing various properties to θ, we will classify e and x as being of a certain type, e.g.:

e, x : INC-THEME

The type INC-THEME is introduced to try to capture the relationship between an event and an object in cases where there is a relation of "graduality" between event and object. Such cases include the ones discussed above like 'eat an apple' and 'climb a mountain'. There is a clear intuition here that the progress of the event is somehow "marked out" by what happens to the object during the course of the event. This is relatively clear in the case of eating an apple — the apple gradually disappears — we can think of there being a **mapping**, to use Krifka's term, between the progress of the event and how much of the apple is left. The case of climbing a mountain is slightly different, because of course nothing happens to the mountain here, in the sense that the mountain is not consumed or created by the climb. What changes throughout the event, and serves to mark out the course of the event, is the **position** of the climber on the mountain. Then there are examples where an object is gradually created during the course of the event, such as the event of writing a letter or painting a picture. And there are cases where parts of the object, but not the whole object, are gradually affected (such

[17] Although there appears to be no reason why this could not be done.

as painting a house, where only certain parts of the house are painted). Finally, we mention cases where some property of the object gradually changes during the course of the event. These include events like dyeing a t-shirt, where the event is measured out by the intensity of colour of the object (imagine a white t-shirt being immersed in red dye and gradually changing from white through pink to red).

Clearly, all these event/object pairs have something in common — some notion of correspondence or mapping between the state of the object and the progress of the event. Yet even 'state of the object' does not sound right — we don't think of a book changing state as it is read, or a mountain changing state as it is climbed (although note that it is possible to describe a book as 'half-read', whereas one cannot describe a car as 'half-driven'). Driving a car is an example of an event where no such relation of correspondence obtains between the event and the direct object. If, however, we add a destination, and speak of 'driving a car to Glasgow', then there is a relation of graduality between the event and the distance of the car from its destination.

How exactly can we characterise the relation we have called 'graduality' or 'correspondence' between events and individuals? Krifka attempts to do this by defining a property of thematic relations that he calls **gradual patient**.[18] He defines **gradual patient** in terms of other properties such as 'mapping to objects' and 'mapping to events'. 'Mapping to objects' captures the notion that for every part of the event there is a corresponding part of the object. This is easy to envisage in cases like 'eat an apple' where the object is gradually consumed - every part of an eating of the apple corresponds to a part of the apple. However, this does not appear to be quite the right notion in the case of events like 'dye a t-shirt' where there are no parts of the object that can be said to correspond to parts of the event. A slightly different notion from mapping to objects appears to be needed in these cases. Somehow, we need to tie in our world knowledge that dyeing a t-shirt involves a gradual deepening of the intensity of the colour as the event proceeds. It is not immediately obvious how this can be done. Krifka admits that there are problems with examples like 'build a house', where the event may

[18]Krifka defines other related properties, too, such as gradually-consumed patient, but we will concentrate on **gradual-patient** for expository purposes here.

involve, for example, the erection of scaffolding, but where there is no clear correspondence between the erection of the scaffolding and any particular part of the object. He proposes a way round this involving "standard scenarios" for house-building, which involve putting up scaffolding. However, it is not entirely whether standard scenarios exist in all cases, or how this could be used for examples like dyeing a t-shirt.

Krifka also defines the property 'mapping to events', which is like mapping to objects but the other way round. It says that for every part of the object there is a corresponding part of the event. Once again, this is much clearer in some cases than in others.

Thus, we are left with a highly intuitive notion that we may call 'gradual patient' (or, after Dowty (1991), 'incremental theme') which nevertheless seems to elude precise definition. The only way forward appears to be to introduce a binary type INC-THEME of events and individuals and use it in what follows, while acknowledging that we have not given a precise formal definition. We should say, however, that such a lack of precision and formality often seems to be the case where work involving thematic roles/relations is concerned. (See Dowty 1991 and the discussion in Chapter 4, Section 4.3.2.)

We therefore propose that the lexical entry for 'climbed' should be as follows:

climbed:
(u, utt, ty, f, in, out):v
where ty is:

<table>
<tr><td colspan="3">[subj, u_1] $\rightarrow$ X, [obj, u_2] $\rightarrow$ Y, [pred, u] $\rightarrow$ R, [ev, u_3, utt] $\rightarrow$ S, [time, utt] $\rightarrow$ T</td></tr>
<tr><td>S

R(X,Y,T)</td><td>S,R(X,Y,T)

KEY_0</td><td>S,Y

INC-THEME</td></tr>
</table>

if:

$[[\text{pred},u] \rightarrow \text{climb}] \subseteq f$

$$u \models \begin{bmatrix} \text{use-of:} & \text{`climbed'} \\ \text{cat:} & \{\text{v}\} \\ \text{trans:} & \text{pos} \\ \text{aspect:} & \text{simple} \\ \text{time-ref:} & \text{past} \end{bmatrix}$$

$$u_1 \models \begin{bmatrix} \text{cat:} & \{\ldots,\text{np}\} \end{bmatrix}$$

$$u_2 \models \begin{bmatrix} \text{cat:} & \{\ldots,\text{np}\} \end{bmatrix}$$

$$u_3 \models \begin{bmatrix} \text{ev-type:} & \text{event} \end{bmatrix}$$

$out = in \cup \{[\text{ev},u_3,utt], [\text{time},utt]\}$.

By contrast, in the lexical entry for 'drive' we do not require the thematic relation between S and Y to be of type INC-THEME. Thus the lexical entry for 'drove' would be:

drove:
(u, utt, ty, f, in, out):v
where ty is:

$$\begin{array}{|l||l|}\hline \multicolumn{2}{|c|}{[\text{subj}, u_1] \to \text{X}, [\text{obj}, u_2] \to \text{Y}, [\text{pred}, u] \to \text{R}, [\text{ev}, u_3, utt] \to \text{S}, [\text{time}, utt] \to \text{T}} \\ \hline \boxed{\text{S}} & \\ \text{R(X,Y,T)} & \begin{array}{|l|}\hline \text{S,R(X,Y,T)} \\ \hline \text{KEY}_0 \\ \hline \end{array} \\ \hline \end{array}$$

if:

$[[\text{pred},u] \to \text{drive}] \subseteq f$

$$u \models \begin{bmatrix} \text{use-of:} & \text{`drove} \\ \text{cat:} & \{\text{v}\} \\ \text{trans:} & \text{pos} \\ \text{aspect:} & \text{simple} \\ \text{time-ref:} & \text{past} \end{bmatrix}$$

$$u_1 \models \begin{bmatrix} \text{cat: } \{\ldots,\text{np}\} \end{bmatrix}$$

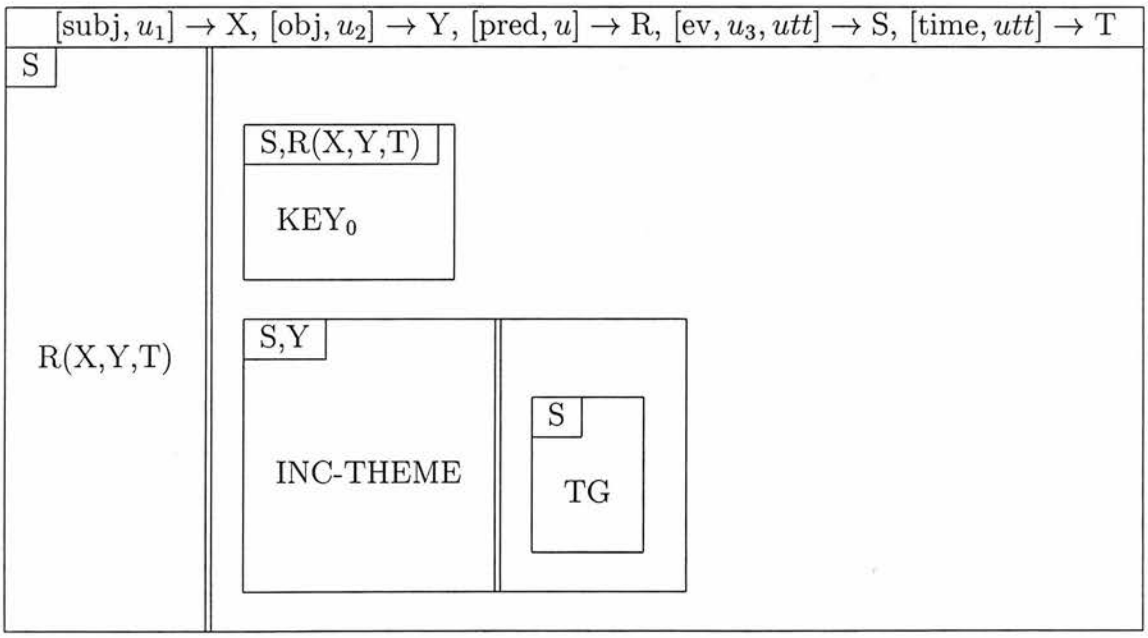
$$u_2 \models \begin{bmatrix} \text{cat: } \{\ldots,\text{np}\} \end{bmatrix}$$

$$u_3 \models \begin{bmatrix} \text{ev-type: event} \end{bmatrix}$$

$out = in \cup \{[\text{ev},u_3,utt], [\text{time},utt]\}$.

We are glossing over several important factors in these lexical entries. First, it should be pointed out that, as Krifka makes clear in his account, thematic relation types such as INC-THEME only hold for situations/eventualities of type TG. For example, there is no relation of type INC-THEME between the eventuality and the filler of the patient role in the case of the eventuality described by "Daniel climbed mountains". We could enforce this restriction by making the lexical entry for 'climb' as follows:

climbed:
(u, utt, ty, f, in, out):v
where ty is:



(etc.)

That is, we restrict

S,Y
INC-THEME

with the proposition that S:TG (see Section 5.3.1 above for the definition of TG for situations). This is in line with Krifka (1992), who limits the gradual-patient relation to hold of quantized event predicates only.

Another possibility is to make INC-THEME a situation-theoretic relation rather than a type. Information about thematic relations would then be situated (i.e., supported by a particular situation). Krifka considers examples which suggest that thematic relation information may well be context dependent. For example, consider the event described by:

(5.43) John saw seventeen lions in an hour

If this describes a trip round a safari park, it apparently makes sense for there to be a relation of type INC-THEME between the patient and the event. We would not normally expect this kind of relation to hold, however, for events involving the relation 'see'. We might express this as:

S′
inc-theme(S,Y)

It is not immediately clear which situation S' would support the infon. Perhaps $S' = S$ — but this would need to be carefully thought out. We will leave this problem aside at least for the time being, and continue to regard INC-THEME not as a relation but as a binary type.

There are other interesting possibilities too. We discussed above how the fact that S, Y:INC-THEME means that S is, in a sense, "temporally measured out" by Y. The progress of Y as time passes corresponds in some way to the progress through time of the eventuality. In an eating event, the patient gradually becomes smaller and disappears as the event proceeds. In a climbing event the progress of the patient (i.e. the mountain) is not quite so straightforward. What happens here is that the position of the agent with respect to the patient changes over time in a way that corresponds to the progress of the climb. The involvement of the agent role here suggests that perhaps we need a slightly different formulation, such as:

S,P	
INC-THEME	S′ position-on(X,Y,P)

where 'position-on(X,Y,P)' holds between an individual X who occupies a position P with respect to an object Y. P would obviously need to be some kind of metric such as the height of X on Y. We will not pursue this further here, but continue to characterise the relation between a climbing event and the object climbed as INC-THEME.

Now we have just said that S can be thought of as "temporally measured out" by Y. Recall that S is the "smallest" or "minimal" situation that supports the relevant infon. But it is also possible that a "bigger" situation than S (i.e., a situation S', where $S \trianglelefteq S'$), may also be temporally measured out by Y. For example, suppose that:

S		S′	
climb(X,Y,T)	and	climb(X,Y,T) happy(X,T″)	are true.

Now, under what circumstances can we say that S' is temporally measured out by Y? It is necessary that S' is temporally "confined" to S — i.e., that S' is temporally included in S. Thus if we introduce a binary type TEMP-MEAS which holds of a situation and an individual if the situation is temporally measured out by the individual, we can say that:

(S, Y):TEMP-MEAS & $(S \trianglelefteq S')$ & (S, T):TIME-OF & (S', T'):TIME-OF
& $(T' \sqsubseteq_t T)$
$\rightarrow (S', Y)$:TEMP-MEAS

Actually, it is hard to imagine T' being properly inluded in T, so we could replace this with:

(S, Y):TEMP-MEAS & $(S \trianglelefteq S')$ & (S, T):TIME-OF & (S', T'):TIME-OF
& $(T' = T)$
$\rightarrow (S', Y)$:TEMP-MEAS

In general, therefore, the type TEMP-MEAS is not persistent with respect to its first argument. However, it becomes persistent under the special conditions that the "larger" situation is temporally coincident with the smaller one.

We can say that:

$\forall S, \theta, X$ $[[S, \theta(X) : \text{KEY}_0$ & $S : \text{CP}$ & $S, X : \text{INC-THEME}] \rightarrow$
$S, X : \text{TEMP-MEAS}]$

which says that for any situation S of type CP whose key infon is $\theta(X)$ and where S and X are of type INC-THEME, S is 'temporally measured out' by x (although once again the notion of a situation being temporally measured out by an object is not an easy one to make precise).

We can now express the required mapping from the properties of objects to the properties of situations. We need a rule to say that if the situation and the filler of the patient role are of type INC-THEME, and the agent and the patient are both QUA, then the situation will be of type TG. We can write this as follows:[19]

$\forall S, R, X, Y$ $[[S, R(X, Y) : \text{KEY}_0$ & $S, Y : \text{INC-THEME}$ & $X : \text{QUA}$ & $Y : \text{QUA}]$
$\rightarrow \;\; S : \text{TG}]$

This rule ensures that a sentence like:

[19]Note that the rule is given for transitive verbs. Intransitives may behave differently, in that in some cases there is a mapping between the **agent** and the event. Such intransitives are known as unaccusatives (see Zaenen 1988, for example). We will not attempt to treat them here, but see no reason why our account could not be extended to deal with them.

(5.44) Daniel climbed a mountain

describes a TG eventuality — because the situation and patient are of type INC-THEME, and both arguments are QUA. We also require a rule which says that if it is not the case that both arguments are QUA, or if the type INC-THEME is not present, then the described eventuality will be TU. Such a rule might be expressed as some kind of default. It would ensure that, for example:

(5.45) People climbed a mountain

describes a TU eventuality, because the agent is CUM rather than QUA here. It would also ensure that:

(5.46) John drove a car

describes a TU eventuality, because INC-THEME does not hold here.

We also want to be able to express the effect of 'for'-adverbials on the temporal properties of the described eventuality. It has been frequently observed in the literature (see, for example, Dowty 1979) that 'for'-adverbials are restricted to combining with sentences that describe TU eventualities, while completive 'in'-adverbials are restricted to combining with sentences that describe TU eventualities. For example:

(5.47) Daniel ate apples for two hours

(5.48) *Daniel ate apples in two hours

(5.49) Daniel ate an apple in an hour

(5.50) *Daniel ate an apple for an hour

However, as has also been observed, 'for'-adverbials combine with some TG-sentences to give iterative readings. e.g.

(5.51) Daniel ran round the park for two hours

Iterative readings like these are not available in all cases, however. For example, (5.50) cannot receive an iterative reading. Krifka points out that this is because it is not possible to eat a particular apple more than once[20] — thus a kind of world knowledge about the relation between events of eating an apple and the apple in question is involved. He dubs this property 'uniqueness of events' — meaning that for a given object there is only one event which corresponds to it. For Krifka, the **uniqueness of events** property is another property (like **gradual patient**) of the thematic relation that holds between events of eating and their patient arguments. He is then able to say that iterative readings are possible in cases like the ones above only if the thematic relation between patient and event does not have the property uniqueness of events.

We can do something similar in our formalism by defining a type UNI-EV which holds between a situation and the patient role of the relation if and only if there is only one possible event for a given object. The possibility of iterative readings with 'for'-adverbials is then limited to cases where the situation and patient are not of type UNI-EV.

We will now turn to verbs which express culminations, and discuss the nature of the lexical entries required for them. For example, consider transitive 'finish', as

[20]This does not address the interesting related question of why 'for two hours' is not able to take wider scope than 'an apple', thus allowing Daniel to eat a number of different apples over the two hour period. Indeed, in some contexts this kind of reading does seem to be possible. For example:

(5.52) Daniel ate an apple for ten years

can receive this kind of reading if the preceding context has involved a discussion of lunchtime eating habits. The queston of the nature of 'for'-adverbials and their scoping properties is an interesting one which, however, we will not pursue further here.

in 'finish the chapter'. 'Finish' is a culmination verb which means, as we said above, that it is used to describe an event which is the endpoint or culmination of another event of type CP. We said earlier that the existence of the CP may be inferred from the description of the culmination. It is interesting to consider briefly what the nature of the inferred CP may be, in the case of the verb 'finish'. Consider:

(5.53) John finished an apple

Presenting (5.53) in an empty context seems to invite us to infer that the related CP was an event of John **eating** an apple. However, even if we retain the object argument 'an apple', alternative contexts may be set up which invite different inferences. For example, if John is helping to make an apple pie, his father might well ask him the question:

(5.54) Have you finished your apple yet?

meaning "Have you finished peeling your apple?" Many other similar examples, giving a range of inferred CPs, can be constructed. The question of what restrictions there are on the CPs we may infer is too complex to go into here. Related work on the French 'commencer' has been done recently by Godard and Jayes (1993), where the authors show that the subject must be the "main controller" of the inferred event. The constraints on English 'begin' appear to be similar ('start', however, behaves differently).

Because of these complications, we will not try to specify here the type of the inferred CP. The important point for us is that *some* CP may be inferred from a culmination. Our lexical entry for 'finish' will need to encode information concerning this. Krifka does not discuss culminations/achievements, so we will need to find a way to deal with these.

Culminations behave in a similar way to CPs in that the CUM/QUA value of the object may be transferred to the event. In the case of CPs, this "mapping" only occurs when the eventuality and patient are of type INC-THEME. However, in the case of culminations such mapping always appears to occur. For example, the eventuality described by:

(5.55) John finished an apple

is of type TG, because the object is QUA. In a similar way, the eventuality described by:

(5.56) John finished apples

is TU, just as the object is CUM.

We will express this by saying that, for any (transitive) culmination verb, the eventuality and patient are of type CULM-THEME. Then we can say:

$\forall S, R, X, Y$ $[[S, R(X, Y) : \mathrm{KEY}_0$ & S, Y : CULM-THEME & X : QUA
& Y : QUA]
$\rightarrow$ S : TG & S : CULMIN]

Note that Y may correspond to 'three apples', for example, as well as 'an apple'. Similarly, X may be 'John' or 'four people', for example. In the non-singular cases, the inference that the described event is the culmination of a related CP still appears to be correct. For example, in the case of:

(5.57) John finished four apples

we are taking the described situation to be the culmination of an inferred situation which corresponds to the "whole situation" where, let us say, John eats four apples. In addition to this, we would also want to be able to infer the existence of four eventualities, each corresponding to one apple. Of course, it is not necessary for any or all of these smaller eventualities to be temporally "connected". We might think of John taking a bite from each of the apples in turn, for example. We will not attempt to deal with these complications here.

We can now write the lexical entry for 'finished' as follows:

finished:
(u, utt, ty, f, in, out):v
where ty is:

<table>
<tr><td colspan="2">$[\text{subj}, u_1] \rightarrow \text{X}$, $[\text{obj}, u_2] \rightarrow \text{Y}$, $[\text{pred}, u] \rightarrow \text{R}$, $[\text{ev}, u_3, utt] \rightarrow \text{S}$, $[\text{time}, utt] \rightarrow \text{T}$</td></tr>
<tr><td>S

R(X,Y,T)</td><td><table><tr><td>S,R(X,Y,T)

KEY_0</td><td>S,Y

CULM-THEME</td></tr></table></td></tr>
</table>

if:

$[[\text{pred},u] \rightarrow \text{finish}] \subseteq f$

$$u \models \begin{bmatrix} \text{use-of:} & \text{`finished'} \\ \text{cat:} & \{\text{v}\} \\ \text{trans:} & \text{pos} \\ \text{aspect:} & \text{simple} \\ \text{time-ref:} & \text{past} \end{bmatrix}$$

$$u_1 \models \begin{bmatrix} \text{cat:} & \{\ldots,\text{np}\} \end{bmatrix}$$

$$u_2 \models \begin{bmatrix} \text{cat:} & \{\ldots,\text{np}\} \end{bmatrix}$$

$$u_3 \models \begin{bmatrix} \text{ev-type:} & \text{event} \end{bmatrix}$$

$out = in \cup \{[\text{ev},u_3,utt], [\text{time},utt]\}$.

We have provided an outline of how we might develop some lexical entries and how aspectual composition could be handled by the grammar.[21]

It should be possible, as we said earlier, to write rules to handle **unaccusative** verbs (Zaenen 1988), where the nature of the subject/agent argument affects the

[21] We would also require some kind of "default" rule which ensures that if the thematic relation is neither CULM-THEME nor INC-THEME, the result would be that S is of type TU. We will not include this rule here as we are not attempting to give a complete set of rules but rather to indicate how such rules may be developed.

TU/TG properties of the described eventuality. We will not attempt to do so here, however, but regard this as a topic for further work.

5.4.3 Summary

We have shown how an information-preserving account of aspectual composition based on that given by Krifka (1992) may be expressed in situation-theoretic terms.

We discussed how Krifka's properties of thematic relations may be expressed as binary types of eventualities and argument roles.

We developed lexical entries for verbs that express aspectual distinctions, and rules that govern how these verbs combine with object and subject NPs to give descriptions of eventualities whose properties depend on lexical properties of the verb and properties of the NP arguments.

5.5 Conclusion

The aim of this chapter has been to apply the situation-theoretic theory of events which we developed from observations regarding 'then', 'at the time' and 'at the same time' in discourse, to issues that are generally treated on an intra-sentential level, such as aspectual class distinctions and aspectual modification.

We began by examining the various approaches that have been taken in the literature. We discussed the notion of aspectual class and what exactly it classifies, and settled in favour of viewing it as a classification of eventualities. In our situation-theoretic treatment, eventualities are situations, which in turn are parts of the world as individuated and classified by speakers. We used Moens' nucleus structure for events, combined with situation-theoretic channels and constraints, in order to define types of eventualities and the information they convey about related eventualities.

Next, we studied various accounts of aspectual modification and argued for an information-preserving approach such as those developed by Verkuyl and Krifka.

We showed how Krifka's notion of properties of thematic relations may be expressed in situation-theoretic terms as binary types of eventualities and arguments, and how this information may be used to specify how the aspectual properties of the described eventuality are affected by the nature of the NP arguments.

Chapter 6

Conclusions and Further Work

In this chapter we give a summary of the thesis, draw a number of conclusions, and present some ideas for further work.

We began by examining the distribution of sentence-final 'then'. Our analysis revealed that it is necessary to distinguish between two uses of sentence-final 'then', these being:

1. The ETR use, where 'then' refers back to an explicit temporal referent (ETR), which may be a frame adverbial (e.g. 'in July') or an instantaneous adverbial (e.g. 'at 2pm').

2. The PART-OF use, where 'then' requires/conveys that the most recently-described eventuality is part of the eventuality immediately preceding it in the discourse.

We saw from this that it is necessary to distinguish in our semantic representations between discourse referents which have been explicitly introduced (or "named") by the discourse and those which are inferred by the hearer from the mention of other entities. This is the case even where such an inference is unavoidable. For example, we showed that any eventuality may have a "time" associated with it, which the hearer may infer in order to interpret the temporal structure of the discourse. However, we showed that sentence-final 'then' may not be used in general to refer to such an inferred time. It may only be used if the time was explicitly mentioned by means of an ETR such as a temporal frame or instantaneous adverbial.

We should point out here that more work is needed to decide precisely what kind of temporal adverbial constitutes an ETR. It is clear that frame and instantaneous adverbials meet the necessary requirements, and also that 'for'-adverbials do not qualify as ETRs. However, there are many other kinds of temporal adverbial which should be investigated, such as 'until', 'since', 'before' and 'after', 'while' and 'when' constructions.

For example, there is some evidence that a 'when'-clause may act as what we have been calling an ETR. We saw in Chapter 2 that a sequence like:

(6.1) a. John went to Paris
b. Mary went to Frankfurt then

only makes sense if there is some connection (e.g. elaboration) between the two events. On the other hand, in the sequence:

(6.2) a. John went to Paris in July
b. Mary went to Frankfurt then

there need be no connection between the events — it is enough that both events are linked to the common time, 'July'. Note that a 'when'-clause may act in exactly the same way as 'in July' here:

(6.3) a. John went to Paris when Jane went to the USA
b. Mary went to Frankfurt then

Here, there need be no link between the John's going to Paris and Mary's going to Frankfurt. It is sufficient that both of these events are linked to the event of Jane going to the USA. In other words, (6.3b) simply means the same as:

(6.4) Mary went to Frankfurt when Jane went to the USA

just as (6.2b) means the same as:

(6.5) Mary went to Frankfurt in July

So it appears that what is important is not that the ETR names a time, but that it names another entity (which may be a time or an event) to which the main clause eventuality is related. The presence of such an entity serves to break the link between the two main clause eventualities described in the discourse — it is no longer necessary for them to be linked to each other, as both are linked to the "additional" entity, be it a time or an event.

This suggests a generalisation of the account of 'then' we gave in Chapter 2. The term ETR should perhaps be replaced by a new term. It is not being an explicit temporal referent that matters, but being an entity that is somehow *external* to the discourse structure — an entity to which events that lie within the discourse structure may be related.

We realise that much more work is needed here to confirm whether this is the right way to extend the account, and, if so, to make the new proposal more concrete and formal. Investigation into the other types of temporal adverbial mentioned above may well prove illuminating here. We will make some comments on 'after then' below.

There is also an interesting parallel between sequences with sentence-final 'then' and sentences containing 'when'-clauses. We saw that a sequence like:

(6.6) a. Mary wrote a paper
b. John took the children to Aviemore then

is acceptable if (b) can be seen as an elaboration of (a). In order to do this, the hearer must be able to find some link between the two eventualities. For example, if the hearer knows that John took the children to Aviemore to give Mary peace and quiet to write her paper, this would constitute such a link. The discourse relation can then be seen as one of **elaboration**, and the sequence is acceptable. If no such link can be found, the sequence sounds very odd, as in, for example:

(6.7) a. Mary wrote a paper
b. The Labour party held their annual conference then

which sounds very strange if we cannot conceive of any connection between Mary and the Labour party conference.

Note that we get exactly the same effect with the corresponding 'when' construction:

(6.8) John took the children to Aviemore when Mary wrote her paper

Compare (6.8), which sounds perfectly acceptable, with:

(6.9) The Labour party held their conference when Mary wrote her paper

which sounds extremely odd. Moens (1987) discusses examples like (6.8) and (6.9), and accounts for them by saying that a 'when' construction conveys contingency between the event in the main clause and the event in the 'when'-clause. In other words, he proposes that the meaning of 'when' is not merely temporal, but conveys some kind of connection between the two eventualities.

Of course this is very similar to what we are proposing for 'then'. What Moens calls 'contingency', we have explained in terms of the PART-OF relation between eventualities.

Moens notes too that, where statives are concerned, no contingency between eventualities is necessary, and the relation may be purely temporal. For example, in cases like:

(6.10) The Falklands war was in progress when Emily was born

there need be no contingency between eventualities. Once again, this ties in with our observation that the sequence:

(6.11) a. Emily was born
b. The Falklands war was in progress then

is acceptable. We explained the acceptability of this sequence in terms of the **background** relation, which is an instance of PART-OF.

This very clear parallel between 'then' sequences and 'when' constructions merits further investigation. Perhaps what Moens calls 'contingency' corresponds more-or-less exactly to what we have called PART-OF? If so, it would be interesting to look at Moens' observations on 'when' in greater detail, and try to give an account in terms of the PART-OF relation.

Before we move on we should mention some recent observations we have made concerning 'after then'. Note how bad 'after then' sounds in the sequence:

(6.12) a. John went to Frankfurt
b. *After then he went to Paris

Here, it seems that we should replace 'after then' with 'after that'. Note, however, that 'before then' is completely acceptable in a similar sequence:

(6.13) a. John went to Frankfurt
b. Before then he went to Paris

(And, incidentally, note that 'before that' is also acceptable here.)

Why should there be this difference between 'before then' and 'after then' — when 'before' and 'after' are normally thought of as symmetrical about "now"?

Perhaps there is something superfluous about 'after then' in (6.12a,6.12b), given that we could replace 'after then' with 'then'? But in that case why is 'after that' acceptable?

It is interesting to try to construct sequences where 'after then' is acceptable. Examples that appear to be generally accepted by informants include:

(6.14) a. Mary won't have finished her book by December 1st
b. She hopes to finish about a fortnight after then

Some speakers expressed reservations about this example, saying that they preferred 'after that'. But it was generally felt to be much better than (6.12a,6.12b).

The obvious difference between (6.12a,6.12b) and (6.14a,6.14b) is that the latter contains an ETR, 'December 1st'. This suggests that 'after then' may require the presence of an ETR in order to be acceptable, although we still need to explain why this is so! We also need to explain why some (6.14a,6.14b) is not completely acceptable to all speakers.

An example where 'after then' appears to generally acceptable is:

(6.15) a. John didn't get married while he was a student
b. It was sometime after then

Although there is no ETR here in the form of a "named time", we have the phrase 'while he was a student'. Recall that we suggested above that perhaps our notion of ETR should be extended to include 'when'-clauses. If we allow it to include 'while'-clauses too, perhaps we can begin to explain why 'after then' is acceptable here.

But why does 'after then' require what we previously called an ETR, while 'before then' doesn't? Can we say that 'after then' must refer to a time and not an event — that is, it conveys that an eventuality follows some specified time? If the eventuality follows not a time but another eventuality, we must use 'after that' instead. But why doesn't 'before then' have these restrictions too? One possibility is that 'after that' means something like "the next event that occurs in our narrative sequence", whereas 'before that' is jumping out of the narrative seqence. Whenever we "follow" the narrative sequence, we are expressing a certain kind of relation between eventualities, and such a relation can be expressed by sentence-initial 'then', 'next', 'afterwards', etc. — but not by 'after then'. In other words, if what we really mean is 'after that eventuality', we must say 'after that' and not 'after then'.

But why is 'after then' acceptable in (6.15a,6.15b)? Here, 'after then' is being used to mean 'after John was a student' and thus refers to an eventuality and not a time. But there is no ETR, so 'after then' should not be acceptable here. Recall, however, that we suggested above that 'while' constructions may be included in what we called ETRs. There is no notion here of narrative progression — John's getting married is simply being related to some other eventuality. This supports the idea sketched above that what gets in the way of using 'after then' is narrative sequencing.

Much more work is needed to develop a complete and formal account from all this. We have simply tried to indicate that here is an area ripe for further study.

Let us return to the main conclusions of our thesis.

The general conclusion that may be drawn from our analysis of sentence-final 'then' is that no matter what theoretical framework we choose to model the semantics of discourse, the required distinction between **explicit** and **inferred** entities must be made in some way or other. We showed how such a distinction can be made in two different frameworks — in DRT (Kamp and Reyle 1993) and in situation theoretic DRT (STDRT) (Cooper 1993a, 1993b). In DRT we found that we could make the distinction by allowing a temporal discourse referent to be introduced into the current DRS only in cases where explicit reference to a time was made by means of an ETR. Thus, an utterance of:

(6.16) Daniel climbed Ben Nevis in July

would cause a temporal discourse referent corresponding to 'July' to be introduced. On the other hand, an utterance of:

(6.17) Daniel climbed Ben Nevis

would cause no such temporal referent to be introduced, because there is no ETR present in (6.17).

We constructed a grammatical fragment which is a modification and extension of Kamp and Reyle's temporal fragment (Kamp and Reyle (1993), Chapter 5). This was achieved by modifying Kamp and Reyle's construction rules to restrict the introduction of temporal discourse referents in the way described above. In Kamp and Reyle's fragment no such distinction is made and a temporal discourse referent may be freely introduced whenever there is mention of an event — no ETR is required. We pointed out that no previous DRT treatment of temporal phenomena has, as far as we know, made the kind of distinction we are proposing. The rules of our fragment generate, we showed, exactly the required readings for sentence-final 'then'.

We pointed out, however, that there may be problems inherent in making the distinction in this way. In a bigger fragment we might find cases where it would be very convenient, if not essential, to introduce temporal discourse referents even when no ETR is present. Indeed, in Chapter 4 when we looked at 'at the time' and 'at the same time', we found it was extremely useful to introduce what we called 'time Roles' corresponding to times inferred from events. Thus we saw that it would be desirable to make the distinction in some other way. We pointed out that what is really needed is to be able to include some information *about the utterance* in our semantic representation — information about how a particular temporal referent was introduced: by means of an ETR or as a result of inference. Conventional DRT does not allow us to include such utterance information in the representation.[1] In Chapter 3 we therefore turned to situation theory, which does allow such utterance information to be encoded. In order to retain the benefits of DRT and its facility to express discourse anaphora, we re-expressed our fragment in STDRT. We showed how the STDRT framework allows us to encode utterance information about how a discourse referent was introduced, and use this in the processing of 'then'. Thus we were once again able to generate the required

[1] Which is not to say that it would be impossible to modify DRT in order to include such information — but the result would be a far from standard version of DRT.

readings for sequences containing 'then', without the disadvantages of the DRT treatment.

We can thereby conclude that it is extremely useful, or perhaps even essential, for a semantic framework to provide the facility to distinguish between explictly described and inferred temporal entities, and this requires in turn that the framework be able to encode and utilise information about the utterance. STDRT appears to fulfil these requirements. We suspect, too, that the need to distinguish between explicit and inferred entities is true of other kinds of entities besides temporal ones, although we have not carried out a detailed investigation here and further work is needed to confirm whether this is the case.

In Chapter 3 we also considered the nature of place Roles, and concluded that further work is also needed on the question of spatial reference in general. It would be particularly interesting to see a detailed investigation of 'there' along similar lines to our investigation of sentence-final 'then'. Preliminary work which we have carried out suggests that there may be constraints on the use of 'there' that parallel in some respects the constraints identified for 'then'. For example, the sequence:

(6.18) a. Jane made a parachute landing
b. *John landed there too

is unacceptable, whereas:

(6.19) a. Jane made a parachute landing in a field
b. John landed there too

is acceptable, showing that the presence of an **explicit spatial referent** (ESR) is required for 'there', which of course is reminiscent of the explicit temporal referent (ETR) required for one of the uses of 'then'. We note too that 'at the same place' does not require an ESR, just as 'at the same time' does not require an ETR. This is illustrated by the acceptability of (6.20a,6.20b) and (6.20a,6.20c).

(6.20) a. Jane made a parachute landing
b. John landed at the same time
c. John landed at the same place

Our brief investigation suggests that there is no reading of 'there' which corresponds to the PART-OF reading of 'then' — which is perhaps not surprising as PART-OF 'then' involves discourse relations which appear to concern time rather than place. However, a more detailed investigation is clearly needed to give a precise semantics for sentence-final 'there' and a fuller account of the nature of spatial referents and place roles in general.

In Chapter 4 we moved on to examine in greater detail some observations made in Chapter 2 about sentence-final 'at the time' and 'at the same time' and their distribution in discourse sequences. We had noted in Chapter 2 that 'at the time' behaves in a similar though not identical way to PART-OF 'then'. The difference is that 'at the time', unlike PART-OF 'then', may not be used when the discourse relation is one of **elaboration**. We had also noted that 'at the same time' appears to require that the current eventuality is not PART-OF the previously described one. This analysis seemed rather superficial, however, and in order to gain a deeper understanding of 'at the time' and 'at the same time' we looked at some related non-temporal examples involving relational nouns such as 'colour'. Our analysis of these led us to develop the notion of generalised Role (GR). We saw that if more than one instance of a particular GR is present, 'the same X' is required, whereas if exactly one instance of the GR is present, 'the X' is appropriate. This allowed us to explain the data for relational nouns like 'colour' in discourse sequences such as (6.21a,6.21b–6.21d):

(6.21) a. Emily has a new coat
b. Fiona's scarf is the same colour
c. *Fiona's scarf is the colour
d. Fiona likes the colour

We were also able to account for similar observations concerning non-relational nouns and 'the same X', such as (6.22a,6.22b):

(6.22) a. Emily watched a film

b. Fiona recorded the same film

and for the related single-sentence examples like:

(6.23) Emily watched and Fiona recorded the same film

and:

(6.24) *Emily watched and Fiona liked the same film

We investigated possible links between our notion of generalised Role (GR) and that of thematic role (or thematic relation) used in the literature. In particular, we explored whether our GRs could be expressed in terms of sets of entailments as Dowty does for his Proto-Agent and Proto-Patient roles (Dowty 1991). We found some interesting correlations here, although these were not exact and more work is clearly required on investigating the precise relationship between GRs and thematic roles and/or sets of entailments. For example, it remains to be decided how many distinct GRs are required and exactly how they should be characterised. The preliminary work we have done here points to the opening up of a possible new area of interest, rather than providing any definitive answers. It should be pointed out, however, that the problem of deciding exactly how many roles there should be and what they are is one that is shared by all previous work that uses thematic roles/relations.

We observed too that the single-sentence data for 'the same' is closely related to that for coordination where 'the same' is not present. For example:

(6.25) Emily V1-ed and Fiona V2-ed the same X

and:

(6.26) Emily V1-ed and Fiona V2-ed the X

(where V1 and V2 are verbs and X is a common noun) appear to behave very similarly with respect to which pairs of V1 and V2 are compatible. We drew attention to the fact that recent studies on the semantic constraints on coordination have suggested that thematic roles are involved. This ties in with the strong links we discovered between GRs and thematic roles, and suggests that further work here may lead to interesting results.

Armed with our analysis of 'the X' and 'the same X', we returned to attempt to explain the distribution of 'at the time' and 'at the same time'. We found that by allowing eventualities to have time Roles and treating these Roles as GRs, we could explain the data. If exactly one time Role is present 'at the time' is appropriate', whereas if more than one time Role is present 'at the same time' is required. This left us with the task of explaining why in some discourse sequences only one time Role is present whereas in other cases there are two.

Consideration of this led us to propose a theory of discourse backgrounding. The backgrounding eventuality (which is always described by a stative or progressive) does not, we concluded, introduce a new situation into the representation of the discourse, but instead adds further information to the situation introduced by the previous utterance. Because each eventuality (situation) has its own time Role, the fact that there is no new situation means that no new time Role is introduced either. This in turn means that 'at the time' rather than 'at the same time' is appropriate in backgrounding cases.

The idea of discourse backgrounding has been widely used (often with slight variations) in theories of discourse structure, but has not to our knowledge been previously formalised. The idea that backgrounding corresponds to a "continuation" of the previous situation rather than the introduction of a new one at least puts some meat onto a rather vague concept. However, the proposal is not entirely unproblematic. We pointed out that observations concerning event anaphora may indicate the need to introduce a new situation for every eventuality, whether or not it is backgrounded. Further work is needed here to see if a way can be found to reconcile the observations from these two areas.

The proposal of a formalisation for discourse backgrounding raises the question of whether it is possible to formalise other discourse relations in this kind of way. As the notion of discourse relation in the literature is a little like that of thematic role (in that it seems one is always at liberty to introduce a new one whenever the analysis requires it), it would be very interesting if a theory could be developed which actually predicts which discourse relations exist and what precisely they mean. This may be a long way off, but we believe that some progress has been made here towards that goal.

In Chapters 1–4 we approached temporal phenomena from what can be thought of as a discourse perspective, looking at how sentence-final 'then', 'at the time' and 'at the same time' interact with and help to determine the relations between eventualities and times that are conveyed by the discourse. We were not primarily interested in matters such as aspectual class and the progressive, which are generally treated from a "sentence-internal" perspective, although we found that the analysis of 'then' etc. inevitably involved us in some consideration of these phenomena.

In Chapter 5 our aim was to further develop the STDRT framework and theory of events set up in the earlier chapters in order to tackle issues like aspectual class and aspectual composition in greater depth. Our hope was that the theory developed so far would provide a useful framework for expressing, comparing and evaluating known insights about these matters and perhaps giving an improved treatment of some of them.

We began Chapter 5 by looking at aspectual class. Building on the work of Cooper (1985), we showed how modelling eventualities as situations enables us to express formally certain properties of these eventualities such as the homogeneous/heterogeneous distinction that separates states and processes (activities) on the one hand from accomplishments and achievements on the other. We developed an account of the internal structure of events based closely on Moens' nucleus theory of event structure (Moens 1987). By using the situation-theoretic notion of **constraint** we were able to express the way that information expressed by an utterance about one part of an event can allow the hearer to infer information about another related part of that event. This allowed us to express many of the ideas present in Moens' theory of event structure and his aspectual network in a precise and formal way. In particular, it allowed us to formalise the notion of "focusing" on a particular phase of an event.

Next we considered aspectual composition. We reviewed the literature on this subject and argued in favour of an information-preserving approach which does not involve the overwriting of previously established information. Such an approach is taken by both Verkuyl (1989) and Krifka (1992), and we showed how a theory of aspectual composition bsed closely on that of Krifka can be expressed in our theoretical framework, again using situation-theoretic constraints and channels.

The work of this chapter demonstrates, we believe, the importance of a theory of information to developing a natural language semantics of events and times. The fact that STDRT makes available situation theory's informational perspective allowed us to express notions of information flow, such as inference, with relative ease. We were able to capture very naturally the distinctions between explicitly described and inferred information found to be necessary to treat the natural language phenomena under investigation. It is hard to see how this could be done without such a theory of information.

In this thesis we stopped short of building the account of aspectual class and aspectual composition into the grammar. Further work is required here to develop an extension of the STDRT fragment which embodies this account. This is not envisaged to be problematic, and some preliminary work has been done and described elsewhere on developing a grammar and related implementation in Prolog that treats both sentence-final 'then' and aspectual composition (Glasbey 1993b).

Future Directions

We showed in Chapter 4 that the progressive may convey either backgrounding or non-backgrounding in discourse. This has implications for accounts of the progressive which follow (Vlach 1981) in regarding the progressive as a stativiser. We show elsewhere (Glasbey 1994a) that our analysis of backgrounding poses problems for such accounts. This leaves us with the need for an alternative account of the progressive. Such an account is proposed by (Smith 1991), employing Smith's two-component theory of aspect described therein. We show in (Glasbey 1994a) that such an account, which regards progressive aspect as a speaker viewpoint or perspective independent of aspectual class, may be expressed in the STDRT framework, and how some problems in Smith's DRT formalisation may be overcome by using the situation-theoretic notions of event-type and PART-OF. Problems with the imperfective paradox remain, and we consider that channel theory (Barwise and Seligman in press) may have something to offer here in allowing us to capture notions like normality, expectation or reasonable outcome, which have been shown by a number of researchers, including Dowty (1979), Hinrichs (1983), Cooper (1985) and Landman (1992), to be an essential part of the meaning of the progressive. In (Glasbey 1994b) we present an initial proposal for an analysis of the progressive using channel theory.

A constantly recurring theme throughout this thesis has been the need to distinguish between explicitly described and implicit or "inferred" information. The need for this became apparent in our analysis of 'then', and reappeared as we studied aspectual class and event structure. It became clear that any theoretical framework chosen for a natural language semantics of events and times must be capable of expressing such a distinction in a form that is readily accessible to grammatical processing. We showed that the informational component of STDRT allowed it to fulfil this requirement and thus to express a coherent account of the various temporal phenomena treated in this thesis. We have not, of course, we shown that STDRT is the only framework capable of embodying such a distinction.

We showed too how the theory of events developed from the analysis of discourse phenomena such as 'then' trickled down in a useful way to the investigation of aspectual class and aspectual composition. It seems abundantly clear that none of these should be thought of as purely sentence-internal phenomena, but instead should be studied in the context of the discourse in which they are embedded.

Bibliography

Aczel, P. and R. Lunnon (1991) Universes and parameters. In J. Barwise, J. M. Gawron, G. Plotkin and S. Tutiya, eds., *Situation Theory and its Applications*, Vol. 2, pp. 3–24. Stanford, Ca.: Center for the Study of Language and Information.

Bach, E. (1986) The algebra of events. *Linguistics and Philosophy* **9**(1), 5–16.

Barwise, J. (1981) Scenes and other situations. *Journal of Philosophy* **78**(7), 369–397.

Barwise, J. (1989) *The Situation in Logic.* Stanford, Ca.: Center for the Study of Language and Information.

Barwise, J. and R. Cooper (1981) Generalized quantifiers and natural language. *Linguistics and Philosophy* **4**(2), 159–219.

Barwise, J. and R. Cooper (1993) Extended Kamp Notation: a graphical notation for situation theory. In P. Aczel, D. Israel, Y. Katagiri and S. Peters, eds., *Situation Theory and its Applications*, Vol. 3, pp. 29–53. Stanford, Ca.: Center for the Study of Language and Information.

Barwise, J. and J. Etchemendy (1990) Information, Infons and Inference. In R. Cooper, K. Mukai and J. Perry, eds., *Situation Theory and its Applications*, Vol. 1, pp. 33–78. Stanford, Ca.: Center for the Study of Language and Information.

Barwise, J. and J. Perry (1983) *Situations and Attitudes.* Cambridge, Mass.: MIT Press.

Barwise, J. and J. Seligman (in press) The rights and wrongs of natural regularities. In J. Tomberlin, ed., *Philosophical Perspectives.*

Bennett, M. and B. H. Partee (1972) *Toward the logic of tense and aspect in English.* Bloomington, Ind.: Indiana University Linguistics Club.

Caenepeel, M. and M. Moens (1994) Temporal structure and discourse structure. In C. Vetter, ed., *Tense and Aspect in Discourse.* Berlin: de Gruyter.

Carlson, G. (1977) *Reference to Kinds in English.* PhD thesis, University of Massachusetts, Amherst.

Carlson, G. (1987) Same and different: some consequences for syntax and semantics. *Linguistics and Philosophy* **10**, 531–565.

Carlson, G. N. (1984) Thematic roles and their role in semantic interpretation. *Linguistics* **22**, 259–279.

Cooper, R. (1985) Aspectual classes in situation semantics. Report CSLI-84-14C, Center for the Study of Language and Information, Stanford, Ca.

Cooper, R. (1986) Tense and discourse location in situation semantics. *Linguistics and Philosophy* **9**(1), 17–36.

Cooper, R. (1988a) Grammatical functions, unsaturated possible facts and implicit arguments. Chapter 3 of *Introduction to Situation Semantics*, unpublished draft ms., November 1988.

Cooper, R. (1988b) The interpretation of simple sentences. Chapter 1 of *Introduction to Situation Semantics*, unpublished draft ms., July 1988.

Cooper, R. (1991) Three lectures on situation theoretic grammar. In M. Filgueiras, L. Damas, N. Moreira and A. P. Tomas, eds., *Natural Language Processing: EAIA '90, 2nd Advanced School in Artificial Intelligence, Guarda, Portugal, October 8–12, 1990: Proceedings*, pp. 101–140. Berlin: Springer-Verlag.

Cooper, R. (1993a) Situation theoretic discourse representation theory. Course Notes, Centre for Cognitive Science, University of Edinburgh.

Cooper, R. (1993b) Towards a general semantic framework. In R. Cooper, ed., *Integrating Semantic Theories*, pp. 49–97. DYANA-2 Deliverable R2.1.A.

Cooper, R. (1993c) Generalized quantifiers and resource situations. In P. Aczel, D. Israel, Y. Katagiri and S. Peters, eds., *Situation Theory and its Applications*, Vol. 3. Stanford, Ca.: Center for the Study of Language and Information.

Cooper, R. and J. Ginzburg (1993) Enriched answerhood, goals, and mental state dynamics. Ms., Centre for Cognitive Science and Human Communication Research Centre, University of Edinburgh, presented at the ASL/LSA Conference on Logic and Linguistics, Ohio State University, Columbus, Ohio, July–August 1993.

Crimmins, M. (1992) *Talk About Beliefs.* Cambridge, Mass.: MIT Press.

Crow, J. M. (1990) Locations Now and Then. In R. Cooper, K. Mukai and J. Perry, eds., *Situation Theory and its Applications*, Vol. 1, pp. 355–377. Stanford, Ca.: Center for the Study of Language and Information.

Davidson, D. (1967) The logical form of action sentences. In N. Rescher, ed., *The Logic of Decision and Action.* Pittsburgh: University of Pittsburgh Press.

Devlin, K. (1991) *Logic and Information.* Cambridge: Cambridge University Press.

Dowty, D. (1979) *Word Meaning and Montague Grammar.* Dordrecht: D. Reidel.

Dowty, D. (1991) Thematic proto-roles and argument selection. *Language* **67**(3), 547–619.

Eberle, K. and W. Kasper (1991) Tense, aspect and temporal structure in French. In H. Kamp, ed., *Tense and Aspect in English and French*, pp. 4–40. Centre for Cognitive Science, University of Edinburgh. DYANA Report R2.3.B.

Fillmore, C. J. (1968) The case for case. In E. Bach and R. T. Harms, eds., *Universals in Linguistic Theory*, pp. 1–88. New York: Holt, Rinehart and Winston.

Galton, A. (1984) *The Logic of Aspect: An Axiomatic Approach.* Oxford: Clarendon Press.

Garrod, S. C. and A. J. Sanford (1990) Referential processes in reading: Focussing on roles and individuals. In D. A. Balota, G. B. F. d'Arcais and K. Rayner, eds., *Comprehension Processes in Reading*, pp. 465–486. Hillsdale, N.J.: Lawrence Erlbaum Associates.

Gawron, J. M. and S. Peters (1990) Some Puzzles About Pronouns. In R. Cooper, K. Mukai and J. Perry, eds., *Situation Theory and its Applications*, Vol. 1, pp. 395–431. Stanford, Ca.: Center for the Study of Language and Information.

Glasbey, S. (1990) Tense and aspect in natural language processing: a situation theory approach. Master's thesis, Department of Artificial Intelligence, University of Edinburgh.

Glasbey, S. (1993a) 'The same X' and 'the X' in discourse. Unpublished ms., Centre for Cognitive Science, University of Edinburgh, November 1993. Submitted to *Linguistics and Philosophy.*.

Glasbey, S. (1993b) A computational treatment of sentence-final 'then'. In *Proceedings of the 6th Conference of the European Chapter of the Association for Computational Linguistics*, pp. 158–167, OTS (The Research Institute for Language and Speech).

Glasbey, S. (1993c) Distinguishing between events and times: some evidence from the semantics of *then. Natural Language Semantics* **1**(3), 285–312.

Glasbey, S. (1994a) Progressives, events and states. In *Proceedings of the Ninth Amsterdam Colloquium*, Institute for Logic, Language and Computation, University of Amsterdam.

Glasbey, S. (1994b) Towards a channel-theoretic account of the progressive. Unpublished ms., Centre for Cognitive Science, University of Edinburgh, February 1994. To be presented at the Fourth Conference on Situation Theory and its Applications, St. Mary's College, Morage, California, June 1994.

Godard, D. and J. Jayes (1993) Towards a proper treatment of coercion phenomena. In *Proceedings of the 6th Conference of the European Chapter of the Association for Computational Linguistics*, pp. 168–177, OTS (The Research Institute for Language and Speech).

Herweg, M. (1991) Perfective and imperfective aspect and the theory of events and states. *Linguistics* **29**, 969–1010.

Hinrichs, E. (1983) The semantics of the English progressive: a study in Situation Semantics. In A. Chukerman, M. Marks and J. F. Richardson, eds., *Papers from the Nineteenth Regional Meeting of the Chicago Linguistics Society*, pp. 171–182.

Hinrichs, E. (1986) Temporal anaphora in discourses of English. *Linguistics and Philosophy* **9**, 63–82.

Hudson, R. (1988) Coordination and grammatical relations. *Journal of Linguistics* **24**.

Jackendoff, R. (1987) The Status of Thematic Relations in Linguistic Theory. *Linguistic Inquiry* **18**, 369–411.

Jackendoff, R. (1983) *Semantics and Cognition.* Cambridge, Mass.: MIT Press.

Johannessen, J. B. (1990) Unbalanced coordination: Barriers, binding and thematic relations. Research Paper EUCCS/RP-44, Centre for Cognitive Science, University of Edinburgh.

Johnson, M. and E. Klein (1986) Discourse, anaphora and parsing. In *Proceedings of the 11th International Conference on Computational Linguistics*, pp. 669–675, Bonn University.

Kamp, H. (1979) Events, instants and temporal reference. In R. Bäuerle, U. Egli and A. von Stechow, eds., *Semantics from Different Points of View*, pp. 376–417. Berlin: Springer-Verlag.

Kamp, H. (1981) A theory of truth and semantic representation. In J. A. G. Groenendijk, T. M. V. Janssen and M. B. J. Stokhof, eds., *Formal Methods* *in the Study of Language: Part 1*, pp. 277–322. Amsterdam: Mathematisch Centrum.

Kamp, H. and U. Reyle (1993) *From Discourse to Logic: Introduction to Modeltheoretic Semantics of Natural Language, Formal Logic and Discourse Representation Theory.* Dordrecht: Kluwer.

Krifka, M. (1992) Thematic relations as links between nominal reference and temporal constitution. In I. A. Sag and A. Szabolcsi, eds., *Lexical Matters.* Stanford, Ca.: Center for the Study of Language and Information.

Lakoff, R. (1971) *If's, And's* and *But's* about conjunction. In C. J. Fillmore and D. T. Langedoen, eds., *Studies in Linguistic Semantics.* New York: Holt, Rinehart and Winston.

Landman, F. (1992) The progressive. *Natural Language Semantics* **1**(1), 1–32.

Lang, E. (1984) *The Semantics of Coordination.* Amsterdam: John Benjamins Publishing Co.

Lascarides, A. and N. Asher (1991) Discourse relations and common sense entailment. In H. Kamp, ed., *Default Logics for Linguistic Analysis.* Centre for Cognitive Science, University of Edinburgh. DYANA Report R2.5B.

Lewis, D. (1979) Score-keeping in a language game. In R. Bäuerle, U. Egli and A. von Stechow, eds., *Semantics from Different Points of View.* Berlin: Springer-Verlag.

Löbner, S. (1985) Definites. *Journal of Semantics* **4**(4), 279–326.

Lunnon, R. (1991) *Generalized Universes.* PhD thesis, University of Manchester.

Macken, E. (1990) Out of the Mouths of Babes. In R. Cooper, K. Mukai and J. Perry, eds., *Situation Theory and its Applications*, Vol. 1, pp. 433–448. Stanford, Ca.: Center for the Study of Language and Information.

Mann, W. and S. Thompson (1987) Rhetorical Structure Theory: A theory of text organisation. In L. Polanyi, ed., *The Structure of Discourse.* Norwood, N.J.: Ablex.

Mellor, M. (1993) Composing event templates. In preparation, Centre for Cognitive Science, University of Edinburgh.

Moens, M. (1987) *Tense, Aspect and Temporal Reference.* PhD thesis, Centre for Cognitive Science, University of Edinburgh.

Moens, M. and M. J. Steedman (1988) Temporal ontology and temporal reference. *Computational Linguistics* **14**(2), 15–28.

Moltmann, F. (1992) Reciprocals and *same/different*: towards a semantic analysis. *Linguistics and Philosophy* **15**(4), 411–469.

Montague, R. (1973) The proper treatment of quantification in ordinary English. In K. J. J. Hintikka, J. M. E. Moravcsik and P. Suppes, eds., *Approaches to Natural Language: Proceedings of the 1970 Stanford Workshop on Grammar and Semantics*, pp. 221–242. Dordrecht: D. Reidel. Reprinted in R. H. Thomason, ed., *Formal Philosophy: Selected Papers of Richard Montague*, pp. 247–270. New Haven, Conn.: Yale University Press, 1974.

Montague, R. (1974) On the nature of certain philosophical entities. In R. H. Thomason, ed., *Formal Philosophy: Selected Papers of Richard Montague*, pp. 148–187. New Haven, Conn.: Yale University Press.

Ogihara, T. (1990) The semantics of the progressive and the perfect in English. In H. Kamp, ed., *Tense and Aspect in English*, pp. 3–38. Centre for Cognitive Science, University of Edinburgh. DYANA Report R2.3.A.

Ogihara, T. (1991) Frequency adverbs, temporal adverbial clauses and DRT. In H. Kamp, ed., *Tense and Aspect in English and French*, pp. 65–74. Centre for Cognitive Science, University of Edinburgh. DYANA Report R2.3.B.

Parsons, T. (1990) *Events in the Semantics of English.* Cambridge, Mass.: MIT Press.

Partee, B. H. (1984) Nominal and temporal anaphora. *Linguistics and Philosophy* **7**, 243–286.

Polanyi, L. and R. Scha (1984) A syntactic approach to discourse semantics. In *Proceedings of the 10th International Conference on Computational Linguistics and the 22nd Annual Meeting of the Association for Computational Linguistics*, pp. 413–419, Stanford University.

Pollard, C. and I. A. Sag (1987) *Information-Based Syntax and Semantics*, Vol. 1: *Fundamentals.* Stanford, Ca.: Center for the Study of Language and Information.

Reichenbach, H. (1947) *Elements of Symbolic Logic.* New York: Macmillan.

Rosch, E. (1978) Human Categorization. In N. Warren, ed., *Advances in Cross-Cultural Psychology.* London: Academic Press.

Sandström, G. (1993) When-clauses and the temporal interpretation of narrative discourse. Technical Report 34, Department of General Linguistics, University of Umeå.

Schachter, P. (1977) Constraints on coordination. *Language* **53**(1), 86–103.

Schiffrin, D. (1992) Anaphoric *then*: aspectual, textual and epistemic meaning. *Linguistics* **30**, 753–792.

Seligman, J. and A. ter Meulen (1992) Dynamic aspect trees. Unpublished ms., December 1992.

Smith, C. S. (1991) *The Parameter of Aspect.* Dordrecht: Kluwer.

Spejewski, B. and G. Carlson (1993) Modification of event relations. In *Proceedings of the Twenty-Third Annual Meeting of the NorthEastern Linguistics Society* , University of Massachusetts at Amherst.

Vendler, Z. (1967) Verbs and times. In *Linguistics in Philosophy*, pp. 97–121. Ithaca, N.Y.: Cornell University Press.

Verkuyl, H. J. (1972) *On the Compositional Nature of the Aspects.* Dordrecht: D. Reidel.

Verkuyl, H. J. (1989) Aspectual classes and aspectual composition. *Linguistics and Philosophy* **12**(1), 39–94.

Vlach, F. (1981) The semantics of the progressive. In P. J. Tedeschi and A. E. Zaenen, eds., *Syntax and Semantics*, Vol. 14: *Tense and Aspect*, pp. 271–292. New York: Academic Press.

White, M. (1993) Delimitedness and trajectory-of-motion events. In *Proceedings of the 6th Conference of the European Chapter of the Association for Computational Linguistics*, pp. 412–421, OTS (The Research Institute for Language and Speech).

Zaenen, A. (1988) Unaccusative verbs in Dutch and the syntax-semantics interface. Unpublished ms., Xerox Palo Alto Research Center and CSLI, Stanford University.